DOCUMENT RESUME

ED 120 516 32 CE 006 822

TITLE	Construction Cluster Volume 5 [Electrical].
INSTITUTION	Pennsylvania State Dept. of Justice, Harrisburg. Bureau of Correction.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	1 Jan 71
NOTE	128p.; For the rest of the series, see CE 006 818-821
EDRS PRICE	MF-$0.83 HC-$7.35 Plus Postage
DESCRIPTORS	Building Trades; *Construction Industry; *Curriculum Guides; *Electrical Occupations; *Instructional Materials; Integrated Curriculum; Job Skills; Occupational Clusters; Secondary Education; *Unit Plan
IDENTIFIERS	Elementary Secondary Education Act Title I; ESEA Title I

ABSTRACT

The document is the fifth of a series, to be integrated with a G.E.D. program, containing instructional materials for the construction cluster. The volume focuses on electrical work and consists of 20 instructional units which require a month of study: (1) safety precautions and first aid for electrical workers; (2) planning a simple installation; (3) first electrical experiences; (4) splices, joints, junctions, and connections; (5) and (6) basic electricity (DC) 1 and 2; (7) electrical materials, overcurrent devices, and simple construction; (8) basic electricity (AC); (9) basic electricity (AC) and basic circuits; (10) magnetism and transformers; (11) service entrance and branch circuits; (12) design and wiring of simple AC circuits; (13) reading plans for a whole house; (14) and (15) wiring the whole house; (16) miscellaneous wiring information and wiring large appliances; (17) three-wire; (18) special wiring for residences; (19) circuit failure; and (20) special methods of wiring. Each unit includes the following information for the teacher: aim, instructional aids, equipment, primary references, introduction and motivation, a presentation of integrated concepts, application, evaluation criteria guideline, summary, suggested time and sequence listing, and supplemental references and resource materials. A bibliography and resource list are included. (EC)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

APR 0 6 1976

ED120516

Commonwealth of Pennsylvania
Department of Justice
Bureau of Correction

VOCATIONAL EDUCATION PROGRAM OF STUDIES

Elementary, Secondary Education Act

Title I

CONSTRUCTION CLUSTER VOLUME V

CE008822

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

January 1, 1971
Pennsylvania Bureau of Correction

Harry A. Snyder
Director of Education

INTRODUCTION

The following information comprises one of seven volumes of instructional materials developed around a cluster of Construction Industries and Occupations. These instructional materials are primarily technical in focus but are written to be used in a cluster concept program as part of an integrated curriculum.

The materials are aimed at preparing students with basic skills necessary to enter a number of occupations in industries within the Construction cluster rather than providing an in-depth development of skill in any one occupation.

Each volume contains approximately one hundred twenty hours of instruction (about one month of study) and consists of twenty instructional units each having one or more specific lessons. Each unit is designed for six hours of instruction (three hours of technical laboratory experiences and three hours of related study in science, mathematics, communications and social studies) but may be varied at the instructor's discretion.

The seven volumes or cluster areas in the series are:

Volume I - Wood Structural Framing
II - Masonry Work
III - Plumbing
IV - Concrete Work
V - Electrical
VI - Air Conditioning and Refrigeration
VII - Heating and Ventilation

Students in the Construction cluster should be introduced to the technical and integrated content through several methods closely related to the industrial structure. Among these are line production and assembly, group projects, experimentation, unit studies and independent study. Team teaching techniques should be employed between the academic specialist and the technical specialist and coordinators.

It is recommended that an orientation program be offered students to familiarize them with the cluster areas available so they may select one they wish to pursue. The cluster instruction is designed to integrate with the regular G. E. D. program so students may receive an employable level of skill and a general academic background simultaneously.

As students select the technical cluster areas they wish to study, they should have the option to move through the G. E. D. content at their own speed using programed instructional materials, instructional television, computer assisted instruction and other individualized learning techniques. Technical and integrated concepts are introduced each day by the specialists involved.

After completion of one or more months of work within one cluster, a student could elect to study within another cluster providing, of course, this transfer is agreeable with the counselors, coordinators and instructors involved.

Lessons have been identified in the units. In most cases, however, there is only one lesson since each unit is limited to one

day or six hours of instruction. The units offer the instructor the essential materials, vis-a-vis the aims, instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary and references. The primary and supplemental references are directly related to the topics and are important to the instructors. A selected bibliography is attached at the end of each volume as recommended additional sources of information.

Pagination of the units in this volume has been identified by cluster (C), volume (I, II, etc.), unit (1, 2, etc.) and page (.1, .2, .3, etc.) within each unit.

TABLE OF CONTENTS

UNIT		PAGE
1	Safety Precautions and First Aid for Electrical Workers	C-V-1.1
2	Planning a Simple Installation.	C-V-2.1
3	First Electrical Experiences.	C-V-3.1
4	Splices, Joints, Junctions and Connections.	C-V-4.1
5	Basic Electricity (DC)--Theory and Definitions.	C-V-5.1
6	Basic Electricity (DC)--Meters, Devices, and Measurements.	C-V-6.1
7	Electrical Materials, Overcurrent Devices and Simple Construction	C-V-7.1
8	Basic Electricity (AC)--Terminology, Nature, Values in Single-Phase.	C-V-8.1
9	Basic Electricity (AC) and Basic Circuits--R, C, and L	C-V-9.1
10	Magnetism and Transformers.	C-V-10.1
11	Service Entrance and Branch Circuits.	C-V-11.1
12	Design and Wiring of Simple AC Circuits	C-V-12.1
13	Reading Plans for a Whole House	C-V-13.1
14	Wiring the Whole House.	C-V-14.1
15	Wiring the Whole House (Continued).	C-V-15.1
16	Miscellaneous Wiring Information and Wiring Large Appliances.	C-V-16.1
17	Three-Wire--230 V AC.	C-V-17.1
18	Special Wiring for Residences	C-V-18.1
19	Circuit Failure--Troubleshooting.	C-V-19.1
20	Special Methods of Wiring	C-V-20.1

TABLE OF CONTENTS

UNIT	PAGE
Bibliography	c-V-i
Appendix	c-V-iii

INSTRUCTOR'S UNIT PLAN

Unit 1
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Safety Precautions and First Aid for Electrical Workers

AIM:

To help the student to become a safe worker both for his own sake and for the sake of others.

INSTRUCTIONAL AIDS:

Film - Resuscitation: Mouth-to-Mouth, Mouth-to-Nose, Philadelphia: U. S. Navy Film MD9559-Part 4, Commandant (Code 5242), 4th Naval District, Training Aids Section, Bldg. No. 4 Naval Base (25 minutes).

Film - 115 Volts--Deadly Shipmate, Philadelphia: U. S. Navy Film MN8990, Commandant (Code 5242), 4th Naval District, Training Aids Section, Bldg. No. 4 Naval Base (19 minutes).

EQUIPMENT:

16 mm sound projector and screen.

PRIMARY REFERENCES:

1) Handbook of First Aid--ARC Handbook of the Hospital Corps, Washington, D. C.: United States Navy, U. S. Government Printing Office, 1953 or later.

I. INTRODUCTION AND MOTIVATION

A. Show film: 115 Volts--Deadly Shipmate.

B. Discuss fact that voltage is not the only danger a man can face in the construction trades.

C. What are some other dangers?

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Purpose of first aid.	1. To save a life. 2. To prevent further injury. 3. To preserve resistance and vitality.	1. Know when to apply first aid measures. 2. What to do. 3. Emphasize the need for proper precautions to be followed in work around electricity. a. Discuss proper grounding of circuits b. Discuss dangers and possibilities of short circuits c. Discuss the need for proper insulation
B. General procedures in first aid.	1. Keep patient lying down with head level until his injuries have been determined. 2. Examine the patient for evidence of hemorrhage, cessation of breathing, or other injury. 3. If the patient has received an electric shock and he is not breathing, you should apply artificial resuscitation.	1. Why should a patient have to lie down when he is injured? 2. Why keep the head level? 3. How can you tell if a person is breathing? 4. What is the difference between artificial resuscitation and artificial respiration? 5. Go to the library and get a picture of a Pulmotor. What is a Pulmotor? What is it used for?
C. Show film: Resuscitation, Mouth-to-Mouth, Mouth-to-Nose.	1. Why is it necessary to keep a man breathing even if it is an artificial method?	
D. Organize class into groups of two.	1. Emphasize the need to regain heart action in cases of cardiac arrest.	1. Practice steps necessary to do mouth-to-mouth resuscitation and mouth-to-nose resuscitation on dummy model if available. 2. Discuss and simulate the proper procedures for administering external heart massage. 3. Simulate the simultaneous administration of external heart massage and mouth-to-mouth resuscitation.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. If a man makes $6.00 per hour and is out of work for five months because of a broken leg, how much of a loss in earnings does this represent? 2. The man in problem No. 1 had to borrow $990.00 to tide him over for the last 11 weeks of his injury. If the bank charges 7-3/4% interest, how much does the man have to earn in order to pay back the interest?	1. Assume that you are injured and cannot leave your home. a. There is a leak in your bathroom which the landlord refuses to fix 1) Whom would you contact by telephone? 2) What would you say? b. Assume you cannot contact the landlord by telephone. Write a letter explaining your problem of the leak in the bathroom 1) To the landlord 2) To the local building inspector 3) To the Board of Health 4) To "Action Line"	1. National Safety Council. a. Founded in 1913 b. Chartered by Congress 1953 c. Concerned with accident prevention d. Services available e. Importance
1. A roll of bandage costs $.39. You use approximately 1/4 of the roll to bind a wound. Approximately how much did this amount of bandage cost? 2. Calculate average breathing capacity of class members by measuring and recording air exhaled into inverted water-filled container.	1. Assume you are in charge of a group of men. One of the men was electrocuted. a. Write the report that you would submit to your home office b. Or, write a letter to the victim's wife 2. Write to the American Red Cross explaining your studies and requesting information and materials in the area.	1. Civil Defense - U. S. a. Purposes b. Functions 2. Civil Defense in other countries. a. Similarities b. Differences c. Values compared to U. S.
1. What would you be willing to pay a man who saved your life?		1. Public Health a. Health laws b. Machines equipped with safety devices c. Standards for housing codes d. Codes for ventilation in mines

III. APPLICATION

A. Each man in the construction trade should be cognizant of elementary First Aid. He will usually do the right thing first only if he has been instructed in safety precautions first before an incident happens. The instructor will make it a habit to point out safety violations as they occur. Do this with no embarrassment to the student. Make safety a habit every day. Use the slogan, "Safety First; Safety Always," or, "If you can't figure a way to do a thing safely--how safe is unsafe?"

IV. EVALUATION CRITERIA GUIDELINE

A. What are two purposes of First Aid?

B. When in doubt about the extent of an injury, why should you have the victim lie down?

C. What is the difference between artificial respiration and artificial resuscitation?

D. If you took hold of a live wire and couldn't let go, what should you do?

E. If someone was fast to a live wire, what would you do?

F. Are you being a "sissy" if you take care of minor cuts and scratches?

V. SUMMARY

A. A knowledge of First Aid is necessary to the safety of yourself and others.

B. You must prepare yourself beforehand to react properly in emergencies.

C. Artificial respiration is used on the victims of drowning (there is, or can be, something in the lungs).

D. Artificial resuscitation is used on victims of electrical shock. You only want to restore breathing.

E. First Aid is used to save a life, to prevent further injury and to preserve resistance and vitality.

F. When in doubt about the extent of an injury--don't play doctor--call one.

G. If "stuck" to a live wire--yell!

H. If someone else is "stuck" on a live wire--cut the power the fastest way you can.

I. Safety first is a state of mind preparation. It pays for your life.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction, motivation and film: 115 Volts--Deadly Shipmate

60 minutes -- Math problems in two 30-minute sessions

60 minutes -- Communication and letter writing broken into two 30-minute sessions

90 minutes -- Social studies divided into three 30-minute sessions

60 minutes -- Science and technical concepts

20 minutes -- Group demonstration of how a victim would be prepared for mouth-to-mouth resuscitation

40 minutes -- Summary, evaluation and questions by students

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Levine, S., Vocational and Technical Mathematics in Action, New York: Hayden Book Company, Inc., 1969.

INSTRUCTOR'S UNIT PLAN

Unit 2
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Planning a Simple Installation

AIM:

To introduce the student to elementary electricity and to show him that even a simple wiring job takes planning, knowledge, and familiarity with electrical tools, methods, and materials.

INSTRUCTIONAL AIDS:

Simplified Electric Wiring Handbook, Chicago: Sears, Roebuck Company, 1969.

NEC Code Book, Boston: National Fire Protection Association, 60 Batterymarch Street, 1970.

Film - Legend of Amaquois Valley, Pittsburgh: Westinghouse Electric Corporation, Union Bank Building, 306 Fourth Avenue (23 minutes).

Film - Valley of the Tennessee, Philadelphia: Comm. IV, Navy Yard (29 minutes).

EQUIPMENT:

Chalkboard, chalk, etc.

Sound film projector and screen.

I. INTRODUCTION AND MOTIVATION

A. Show film: Legend of Amaquois Valley.

B. On the basis of the above film, a man who lives in an old house with 1920 wiring and 1970 appliances decides to improve the lighting in his home.

C. Discuss some of the problems he will have to face in order to accomplish his goal.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. First steps. 1. Supply each student with an electrical scale drawing of the cellar. 2. Show placement of: a. Power saw b. Wood lathe c. Convenience outlets d. An electric hot water heater e. Electrical furnace f. An oil fuel-fired furnace g. Electric lights	1. Factors to be considered: a. Local Housing Code b. National Electric Code (NEC) c. Present wiring d. Type of electric service (drop) to use e. Capacity to meet planned present and future needs f. Type and amount of wire to use and buy g. Number of convenience outlets to use h. Number and type of switches required i. Special power tools and appliances to be powered j. How many overcurrent devices k. Type of overcurrent protective devices to use	1. What is meant by an "inadequate service"? 2. What can happen in a house when electrical circuits are overloaded? 3. What is a "service entrance" or "drop"? 4. How can you determine the size and current capacity of a piece of wire? 5. Why are some wires covered with insulation? 6. How much electrical power is required for: a. A power saw b. A wood lathe c. A hot water heater (electric) d. Washer-dryer combination e. A drill press f. A fuel-fired furnace g. A sump pump h. A central air conditioner 7. Compare power consumption of motors and heating devices.
B. Show film: Valley of the Tennessee (by U. S. Office of War Information); procure from: Comm. IV, Navy Yard, Philadelphia, Pa. (29 min.).		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. How much electrical power (total) is required to supply an ordinary cellar which requires an additional 300 watts for lighting besides the list under the Science column? 2. If the man who owned this house decided to have two electricians wire his cellar, how much will this cost if it takes the two men nine hours and they are paid $8.25/hr.? 3. A simple home kit consists of a hammer costing $5.75, three screwdrivers costing $.80 each, a back saw costing $2.75, three pairs of pliers costing $4.50 each, a crosscut saw costing $6.75, and a tool box costing $8.90 is purchased in three equal installments. What is the value of each installment? 4. Calculate the total electric bill for a typical month at a rate of 2-1/2 cents per kilowatt hour.	1. Write a letter to the local housing authority requesting a local Code Book. 2. Write a letter to the U. S. Printing Office, Washington, D. C., and request a catalog of government approved electrical drawings for a small garage. 3. Write a letter to the Penna. State Dept. of Labor requesting information as to the date of the next examination for electrical apprentices. Include a question as to what publications you can get to prepare for this examination (if any exist). 4. Read and interpret insurance regulations that apply to electrical fires.	1. 1965 Department of Housing and Urban Development established. a. Purposes b. Functions c. Impact 2. Substandard housing--need for adequate low cost housing. 3. Recent public housing programs. 4. Urban redevelopment. a. Urban renewal administration b. Model cities 5. Implications of these organizations for electrical contractors.
		1. Suppose, due to an electrical fire, a man's house burns to the ground. Where can he get immediate housing for his family? 2. Suppose in the above case the man has insurance but his policy is destroyed in the fire? What should he do? 3. Suppose his home had been destroyed in a race riot. Will his insurance be paid in full? 4. Suppose you had permission from the local housing authority to rewire your home, but you used the wrong sized wire and because of this faulty wiring, your house burned to the ground. Will your insurance be paid? 5. If you hire your next door neighbor to help you rewire your house and that neighbor breaks his leg, whose insurance company is liable? Yours, his, or neither? 6. What is workman's compensation insurance?

III. APPLICATION

A. To show the student some of the problems incurred in a simple wiring job and to demonstrate to him that knowledge and study as well as planning is required on the part of an electrician. Also the film, Valley of the Tennessee, is shown so the student will be exposed to some of the problems that engineers have to face in order to generate electrical power.

IV. EVALUATION CRITERIA GUIDELINE

A. Name at least five factors that must be considered in order to rewire a cellar.

B. What is a "service entrance"?

C. What is the NEC Code Book?

D. Why should you even bother to see if there are any local housing authority rules before you attempt to rewire an old house?

V. SUMMARY

A. To properly wire a basement or a whole house requires planning, knowledge and familiarity with electrical tools, methods, materials and electrical codes.

VI. SUGGESTED TIME AND SEQUENCE LISTING

25 minutes -- Film: Legend of Amaquois Valley

40 minutes -- Study and discussion of Sears Electric Wiring Handbook

180 minutes -- Discussion of technical and scientific factors that must be considered in order to rewire a cellar

30 minutes -- Discussion and solution of math problems

20 minutes -- Class involvement in how to write letters of request

35 minutes -- Question and answer period on social implications of electrical fires, insurance and especially workman's compensation insurance, especially injuries arising out of a man's employment.

30 minutes -- Film: Valley of the Tennessee

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit	3
Lesson	1
Time	6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: First Electrical Experiences

AIM:

To introduce the student to elementary electrical concepts and to awaken student interest through simple applications of electricity, such as wiring a buzzer, use of buzzers for basic signalling, drawing of simple circuits and the application of electrical symbols for the simplification of drawings.

INSTRUCTIONAL AIDS:

Films - U. S. Navy, Philadelphia:
- MN-8016A - Basic Electricity--The Electron Theory (5 minutes)
- MN-8016B - Basic Electricity--How Magnets Produce Electricity (3 minutes)
- MN-8016C - Basic Electricity--Current Flow--What Is It (3 minutes)
- MN-8016D - Basic Electricity--Electromagnets (2 minutes)
- MN-8016E - Basic Electricity--Basic DC Meter Movement
- MN-8016F - Basic Electricity--What Causes Current Flow--EMF
- MN-8016G - Basic Electricity--What Controls Current Flow Resistance (3 minutes)

EQUIPMENT:

Materials and tools needed to construct a simple buzzer circuit through a 6 V. step-down transformer.

Sound movie projector and screen, several compasses and an electromagnet.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Discuss topic--What is electricity?

B. Show film: Basic Electricity--The Electron Theory, U. S. Navy MN-8016A (5 minutes).

C. Lead up to: Electricity is a force that man has learned to control and use.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. What is energy? 1. If a man moves a weight through a distance to perform work, what does an electrical force move to do work?	1. Energy is the "capacity of performing work." 2. Discuss conductors and nonconductors by making a list of each on the board.	1. What is work? F x D. 2. What is an electron? 3. Compared to moving a pound weight through a distance of one foot, is moving an electron through a distance of one foot very much work?
B. What is current flow? 1. Show film: Basic Electricity--Current Flow--What Is It? (3 minutes). 2. Define: ampere, the unit of electrical current flow.	1. How are current flow and water flow the same? 2. How are they different? Hint: Think of speed. Also, think in terms of faster water current means a constant amount of water moving past a point, but at a faster speed. In an electrical circuit, speed is constant, but more electrons in motion past a given point. (Very valuable concepts.)	1. Is the speed of electrical energy constant? 2. Is it the same traveling through space as it is when traveling in a wire? 3. Define and discuss electrical terms such as amperes, volts, and ohms.
C. What is the nature of the force that causes an electric current to flow? 1. Show film: Basic Electricity--What Causes Current Flow--EMF; USN MN-8016F. 2. Define: volt, the unit of electrical pressure.	1. What is meant by force? (A push or pull, etc.) 2. What does a force do?	1. Discuss briefly: a. Energy cannot be created or destroyed b. Matter cannot be created or destroyed by ordinary means. 2. What happens to electrons in matter that have moved from one atom to another.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. How much work does a man do if he lifts a 16-lb. weight through a distance of two feet? Through 10 feet? Through 1.5 feet 1[illegible] times? 2. Calculate the work input and the energy output of a hand cranked electrical generator.	1. In the library in a physics book, find the weight of an electron in ounces. 2. Write to the local electric company manager and ask him the location of the nearest atomic energy plant in reference to your present school. 3. Find the speed of light (and electrons) in a physics book.	1. Has the concept and definition of an electron had any meaning to the man on the street (the nonscientist)? 2. Is there any newspaper talk in your area about an atomic energy plant?
1. What is meant by a mathematical constant? (Think of Pi.) 2. What is meant by a physical constant? (Think of the speed of light.) 3. Calculate the time elapsed in transmitting an electrical signal from New York to California.	1. In a physics book or library resource book, find out who Bohr was and why he received the Nobel prize.	1. Have the discoveries of Bohr had any effect on modern society? 2. Has the work of Bohr had any effect on <u>your</u> life habits?
	1. If all conductors became nonconductors, write a short list of at least ten items that you use or own which would become useless or obsolete.	1. Tennessee Valley Authority, established 1933. a. Lower cost for electricity b. Private vs. public ownership of public utilities c. Expansion of electric facilities 1) Effect on farm life 2) Effect on standard of living d. Impact on area development for other countries 2. Brief history of electricity. a. Development b. Men 3. Careers in electricity. 4. Importance of electricity in our everyday lives. 5. What would happen to our society if suddenly all electrical wires (conductors) became nonconductors overnight?

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
D. How can electrical currents be controlled? 1. Show film: Basic Electricity--What Controls Current Flow Resistance; USN MN-8016G (3 minutes). 2. Define: resistance, ohm.	1. Why is it necessary to control the flow of an electrical current? 2. Of what materials are resistances made? 3. What makes a material a conductor, a nonconductor, or a resistor? 4. In a sense, is there any such thing as a perfect conductor? Why?	1. Does resistance control the number of electrons that flow past a point, or does it control the speed? 2. Hint: Earlier, we said that the speed of electrical flow was constant. 3. Student experiments with bell wire, flashlight batteries and bulbs. a. Investigate the conductivity of various materials b. Students to design and build simple circuits
E. Besides heat and light, what other effects are produced by the flow of electricity? 1. Show films on magnetism. a. USN MN-8016D - Electromagnets (2 minutes) b. USN MN-8016B - How Magnets Produce Electricity (3 minutes)		
F. How can electromagnets be used? 1. Show film: Basic DC Meter Movement; USN MN-8016E.	1. Why is it necessary to measure electrical current? 2. What is a watt meter? 3. Why is a watt meter connected to every house served by electricity?	1. What is a watt? (A unit of electrical work--keep it simple.) 2. Discuss electrical work. 3. Discuss the measurement of electrical work. 4. Define a kilowatt as 1000 W.
G. Define conditions necessary for a complete circuit. 1. Define a "loop." 2. Hook up buzzer.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. When a home has used 28000 W. of electrical power in one month and electricity sells for $.03/kWh, what is the monthly bill? 2. If you left a 100 W. light bulb on for a full month, what does it add to the total bill?		1. If your house was served by the local electric company and the company went on strike, would this strike have any effect on your school grades? 2. Does the cost of coal and oil have any effect on your electric bill? 3. Find two separate occupations which are used in the electric generator plant.

III. APPLICATION

A. Students will be introduced to elementary electrical knowledge, concepts, and terms. It is necessary to their understanding of the field of house wiring. Emphasis should be placed on all new terms and students should be involved and reinvolved in their usage and proper application.

IV. EVALUATION CRITERIA GUIDELINE

A. What is a volt?

B. What is an ampere?

C. What is the unit of electrical resistance?

D. What is an electron?

E. Besides heat and light, what is another application of electricity?

F. What is an electromagnet?

G. What is one of the important applications of electromagnets?

H. How is electrical current controlled?

I. What conditions are necessary for an electrical circuit to operate?

J. How can a buzzer be used to communicate?

V. SUMMARY

A. Voltage is the pressure that causes an electrical current to flow.

B. The ampere is the unit of electrical current.

C. An electrical current is defined as the flow of electrons in a closed circuit.

D. An ohm is the unit of electrical resistance. A resistor is used to limit and/or control the flow of current.

E. An electromagnetic field surrounds a wire which is carrying current.

F. An electromagnet is a magnet that is produced by the flow of an electrical current.

G. Magnets are the basis for most electrical measuring instruments. A complete loop is necessary for an electrical circuit to "work."

VI. SUGGESTED TIME AND SEQUENCE LISTING

20 minutes -- Introduction and first film

60 minutes -- Nature of electricity, discussion of force, work, current flow, film, etc.

60 minutes -- Nature of electrical force, definition of voltage, laws of conservation of energy and matter, film, etc.

60 minutes -- Control of electrical currents, resistance defined, nature of different types of resistance, materials, film, etc.

60 minutes -- Discussion and demonstration of electromagnet effects, use of magnets, film, etc.

20 minutes -- Basic use of electromagnets in current measuring devices, film, etc.

30 minutes -- Summary and evaluation

50 minutes -- Hook up, test, and discuss buzzer and condition for a complete circuit

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Film Catalog, U. S. Navy, NAVAIR 10-1-777 and Supplements.

INSTRUCTOR'S UNIT PLAN

Unit 4
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Splices, Joints, Junctions and Connections

AIM:

To teach the student some of the important methods and devices used in joining wires together; to familiarize the student with some of the tools commonly used when making splices, junctions, and connections. To give the student materials and time in order to improve his hand-eye coordination by the use of hand tools in the making of joints and splices by actual shop practice.

EQUIPMENT:

Materials and tools necessary for all students to be able to make or do the following: strip wire of insulation; make, solder and tape ten pigtail splices; make, solder, and tape ten tee splices; make five 2-wire and five 3-wire connections with wire nuts of suitable size; make ten splices with Scotchlok connectors; remove outside shielding from BX cable, strip with wire strippers and insert into outlet box with proper connector. Also supply a Sherman fixture connector, several crimp-type connectors, solderless terminals, solderless lugs, "BUG" connectors, etc., as are available at the local supply house. Electrical tape, hacksaws, etc.

PRIMARY REFERENCES:

1) National Electrical Code, Boston: National Fire Protection Association, 60 Batterymarch Street, 1970.

2) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. The first step in the mastery of any trade or skill is familiarization and mastery of basic methods, vocabulary, tools, devices, and nomenclature. No man can ever be considered a master mechanic unless he is able to criticize his own work and be able to see some defect even in the best of his own work. Study the examples shown you. Try to make yours <u>better</u>! Remember, improvement in all skills comes to a man only after an honest and critical analysis of his own personal output. Today you will be taught some basic methods used in the electrical occupations. Do it! Then judge your own work. Be <u>hard</u> on yourself!

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Demonstrate the correct and incorrect way of "skinning" wire.	1. Show why a cut into a wire at right angles to the axis "fractures" easily.	1. Show how a cut along the axis of a wire does not produce the same effect. Discuss the "science" of molecular fatigue in wires.
B. Let students try their "hands" at removing insulation correctly and incorrectly.		1. Let students bend and rebend both correctly and incorrectly skinned wires.
C. Demonstrate the use of "strippers" on Romex, plastic sheathed or similar cable.	1. Outer jackets that cover wires must be tough and flexible; must be easy to pull or "snake" through walls and tight places.	1. Discuss insulation. What it is, why used, etc. 2. Discuss heating of current carrying wires, etc.
D. Let students strip five pieces of Romex or plastic sheathed cable.		1. Discuss weatherproofing. See NEC Art. 100 Definitions.
E. Demonstrate the pigtail splice, solder (optional), and loop splice. Let students make ten splices each.		1. Demonstrate the effect of unclean, loose, or weak electrical connections. 2. Student should check electrical continuity and physical strength of spliced connections.
F. Same for ten western union splices.		
G. Same for ten tee splices.		
H. Same for ten solderless connectors.		
I. Demonstrate how flexible armoured conduit (BX) is cut, stripped and connected. Let students do three of each.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
		1. Use of copper by early man. 2. Daniel Jackling--cheaper mass production of low grade ores. 3. Importance of copper in electrical industry.
1. Keep account of how many bends it takes to fatigue a wire which is correctly and then incorrectly "skinned."	1. Reading and discussion concerning the effect of electrical construction "waste" on the ecological controversy.	1. Where is most of the copper mined in this country? 2. Silver is a better conductor than copper. Why not use silver?
1. Draw a scale drawing of a typical room showing possible electrical outlets and switches. 2. Calculate the amount of wire needed to wire a typical room including allowances for splicing and connections.	1. See NEC code book and familiarize students with Sec. 300-4, 300-5, and 300-8.	
	1. Instructor will circulate among students to encourage and to analyze the efforts of the students; reinforce name of tools, etc.	1. In view of the current thinking in ecology, is it wise to use plastic rather than biodegradable "braids" in house wiring practice?

III. APPLICATION

A. Much of the work of the construction electrician is involved in the making of splices, joints, connections, and junctions. The degree to which an electrician can decide on the type of splice or connection to be made in a given situation is often a direct measure of his ability to function as a master craftsman. The knowledge of, and skill in making splices, connections, and junctions, cannot be overemphasized.

IV. EVALUATION CRITERIA GUIDELINE

A. What is a splice? (See NEC 110-15)

B. What is a pigtail splice?

C. How does a pigtail splice differ from a western union splice?

D. What is a tee splice?

E. What is the final authority in whether a splice is proper or improper for a given application?

F. Why is solder used in splicing?

G. Do you use tape over all splices?

H. What does "weatherproof" mean?

I. Comment on this statement: "Never force a wire through a hole--pull harder!"

V. SUMMARY

A. A splice is the "joining together" of one or more wires. Splices can be accomplished by twisting wires together in a pigtail splice, a western union splice, a tee splice, or by using connectors, "bugs" or screws. The electrician should be familiar with as many types of splices and connectors as possible. Before wires are soldered together, they should first be made mechanically secure. Tape is used to insulate or weatherproof a splice or joint.

B. The NEC code book is generally considered to be the "final authority" in most matters dealing with acceptable procedures and methods in electrical construction. The NEC code book is used fairly often on a nationwide basis.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Introduction and motivation

15 minutes -- Demonstration and testing of correct and incorrect methods of skinning wire

270 minutes -- Demonstration and lab practice in making, soldering, and taping splices. Nomenclature and use of tools, practice, etc.

40 minutes -- Testing and evaluation

20 minutes -- Summary

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Levine, S., Vocational and Technical Mathematics in Action, New York: Hayden Book Company, Inc., 1969.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

INSTRUCTOR'S UNIT PLAN

Unit 5
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Basic Electricity (DC)--Theory and Definitions

AIM:

To teach the student the basic terms and fundamental principles of electricity.

INSTRUCTIONAL AIDS:

Slides - BE1: Introductory Unit, plus manual, St. Cloud, Minn.: Instruct-A-Kit, Division of the Dansen Manufacturing Company, Inc., Cooper at First, Box 70.

EQUIPMENT:

Overhead projector, screen.

Chalkboard, chalk, eraser, etc.

Small motor wired to run. An assortment of 100 color-coded resistors.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970 (Chapter 2).

I. INTRODUCTION AND MOTIVATION

A. Turn lights on and off.

B. Question: What causes the light to go on and off?

C. Electricity, of course!

D. Turn motor on and off.

E. Question: What causes the motor to start and stop as I command it to do so with a flick of a switch?

F. Electricity, of course!

G. What is electricity? What are the laws that govern it? How is it created? Can anyone learn how to control it? Is it possible for electricity to get "out of control"?

H. Today, we will study the nature of electricity and some of its principles. Also, you will need to learn, and in many cases, define some new words that have to do with the science of electricity.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Show slides: 1. BE1 - 1 - The Elements. Discuss. 2. BE1 - 2 - Ions. Discuss. 3. BE1 - 5 - Batteries and Lamps. Discuss.	1. Discuss the electron and the proton.	1. When the concept of the electron has been discussed, define electricity as "the flow of electrons in a closed circuit." Also mention that the exact nature of electricity is unknown except as defined by our knowledge of the electron theory.
B. Some aspects of electrical phenomenon can be compared to water and water flow.	1. Electricity flows at a constant rate of something over 186,000 miles per second.	1. Discuss the atomic theory. 2. Discuss the electron theory. 3. Students to construct simple generator with magnets and wire coils.
C. Show slide: 1. BE1 - 6 - Relationship of Charges.	1. What is a "charge?" Discuss. 2. Discuss and define polarity.	1. Discuss electrical charges. Be sure to mention that like charges attract and unlike charges repel. 2. Student experiments with pith balls and static electricity.
D. Show slides: 1. BE1 - 7 - Voltage. 2. BE1 - 8 - Sources of Voltage. 3. BE1 - 9 - Amperage. 4. BE1 - 10 and 11 - 5. BE1 - 12 - Resistor Color Code. 6. Have each student "interpret" the values of ten resistors.	1. Discuss voltage--electrical force in terms of a physical force. 2. Discuss voltage sources. 3. Mention speed of current has nothing to do with number of electrons because speed always is 186,000+ miles/second. 4. What is resistance? a. Discuss BE1 - 10 b. Discuss BE1 - 11 5. Explain necessity for a standardized color code. Also explain that it was to be noted that in flexible cable that one wire was black, one was white, and one was bare.	1. What is a force? Define. 2. Is voltage the same as power? 3. Is current the same as power? What is a coulomb? 4. Is resistance a necessary factor in our physical world? 5. To memorize the "order" of the colors in the color code, use the following sentence: Bad Boys Race Only Young Girls Behind Victory Garden Walls.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. The electron and proton are weighed on the atomic scale. Proton weight = 1820 x electron weight.	1. The word electron is derived from the Greek language. Look up its meaning in the dictionary.	1. Where would you place man in history if you removed all traces of electricity from our present culture? 2. Alessandro Volta's contribution to electricity.
1. The sun is approximately 93,000,000 miles from the earth. How long would it take to send a radio wave to the sun and back?		1. In a physics book, look up the name Neils Bohr. What did he do?
1. What would be the net result if you had 18 positive charges and 21 identical negative charges? Suppose you reversed them.		
1. A one watt carbon resistor costs 15¢. How much will six resistors cost? 18 resistors? n resistors? 2. Sixty resistors cost $8.40. What is the cost of each resistor? 3. Students can interpret and record resistance values from various color coded resistors.	1. Prefixes: kilo, mega, milli, micro, apply to kilometer, kilocycle, megacycle, etc.	1. What is work? 2. Discuss "Victory Gardens" in World Wars I and II. 3. Revolutionary effect of electricity in communications.

III. APPLICATION

A. Some knowledge of the electron and atomic theories is necessary to the understanding of electrical principles. The student will, when in the trade, use the terms: voltage, current, resistance, etc. The student will also be concerned with the factors that affect resistance. He will also need to know common electrical codes for wires, for resistors, and be familiar with the NEC code book.

IV. EVALUATION CRITERIA GUIDELINE

A. Define electricity according to the electron theory.

B. The speed of an electrical current is something over _____ mi./sec.

C. Like charges _____ and unlike charges _____.

D. What is meant by polarity?

E. Name the unit of electrical pressure.

F. How does one coulomb compare to a gallon of water?

G. Name three sources of voltage.

H. Name three factors that offset resistance.

I. How does one ampere and one coulomb compare?

J. A resistor is red, yellow, green, and silver. What is its resistance?

K. You need a 1000 resistor, 5%. What colors would you look for?

V. SUMMARY

A. The atomic theory states that all matter is composed of approximately 103 elements. An atom is the smallest "bit" into which any element can be broken without losing its elemental identity. The electron theory postulates that atoms can be broken into smaller units of opposing polarities called electrons (negatively charged) and protons (positively charged).

B. Electrons in motion in a closed circuit define an electrical current according to the electron theory.

C. Electricity can be produced by heat, light, friction, chemical, and mechanical means.

D. The volt is the unit of electrical pressure.

E. The ampere is the unit of electrical current.

F. The ohm is the unit of electrical resistance.

G. Resistance varies as to type of material, length, cross-sectional area and temperature.

H. Color codes are standardized methods used for "recognition" of polarities, values, and tolerances.

I. Like electrical charges repel each other; unlike charges attract each other.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Present motivational question and answer topics

20 minutes -- Elements, ions, etc.

30 minutes -- Atomic and electron theories

30 minutes -- Charges, polarity, and relationship of charges

20 minutes -- Electrical pressure

20 minutes -- Sources of voltage

20 minutes -- Flow of electrical current

20 minutes -- Resistance and factors affecting

120 minutes -- Resistance color code and need for codes, plus practice in reading color code

65 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Graham, K. C., Interior Electric Wiring, Chicago: American Technical Society, 1963 or later.

2) Stollberg and Hill, Physics--Fundamentals and Frontiers, Boston: Houghton-Mifflin Company, 1965, p. 103.

INSTRUCTOR'S UNIT PLAN

Unit 6
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Basic Electricity (DC)--Meters, Devices, and Measurements

AIM:

To familiarize the student with, and give the student practice in, measuring voltage and current on the Lab-Volt 555 Student Exploratory Lab Unit. To familiarize the student with simple series and parallel circuits. To have the student learn, practice, and apply Kirchhoff's two laws to various circuits. To familiarize the student with Ohm's law.

INSTRUCTIONAL AIDS:

One Student 555 Exploratory Electronic Laboratory Work Station for each two students. (Available from Buck Engineering Company, Inc., Farmingdale, New Jersey.) (N.B.: Changes can be made in unit for special programs according to Mr. Edward Sosnowski, Buck Engineering Company consultant.)

EQUIPMENT:

Chalkboard, etc. Rest of equipment supplied with above.

PRIMARY REFERENCES:

1) Exploratory Electronics, Farmingdale, New Jersey: Buck Engineering Company, Inc., 1970 Teacher's Edition.

I. INTRODUCTION AND MOTIVATION

A. A hammer is a tool. A wrench is a tool. Knowledge is a tool. Today, we will learn some ideas that serve as tools in the field of electricity. We will learn how to read meters and how to take readings with meters.

B. In addition to these skills, we will learn some simple circuitry and the laws that apply to electrical circuits.

C. If, in the beginning, it tends to get a little mixed up--don't worry! This is natural because many of the ideas (and vocabulary) will be new to you. If this happens, remember the ancient Simian proberb: "What one fool can do, another fool can do!"

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. In prior lesson, we learned that voltage is electrical pressure, amperage is electrical current, and ohmage is electrical resistance.	1. One volt is defined as: 2. One ampere is defined as: 3. One ohm is defined as:	1. Show simple series circuit consisting of one volt, one ampere, and one ohm.
B. Turn to page (ix) in Exploratory Electronics and show how electrical meters serve the electrician the same as a speedometer serves a truck driver. Explain scales, etc. on pages x and xi. Set up Lab-Volt 555 Exploratory Lab. Practice reading voltages and currents. Resistance readings will be done later.	1. Explain what is meant by direct current (DC).	1. Explain the simple functions of the 555 Exploratory Lab to the students. Do not touch on AC modes except in passing. AC will be covered in later lectures. 2. Demonstrations and student experiments with both series and parallel circuits. a. Effect of varying resistance, amperage, and voltage in circuit b. Predict and measure various meter reading points in circuits c. Demonstrate and caution against short circuits d. Demonstrate the interrelationships between volts, ohms and amps in circuit e. Experiment with switch placement in circuits
C. Turn to page 1-1 and do experiment to study "complete" circuit parameters.	1. Factors necessary: a. Source of power b. A load (lamp, etc.) c. A complete loop or path d. Control (switch)	
D. Discuss Learning Experience No. 2 on page 2-1.		
E. Discuss Learning Experience No. 5 on pages 5-1 to 5-4.		

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Draw schematic drawing of typical series and parallel circuit. a. Given voltage and resistance, predict amperage b. Calculate total resistance in both series and parallel circuits c. Calculations above may be checked by experimentation.		1. George Ohm's contribution to electricity. a. Early neglect of his discovery b. International standard adopted 1893.
	1. Explain the meaning of electrical "power source(s)." 2. Look up the word "meter" in the dictionary.	1. How would you know how much gas you put in your car if there were no meters? Could you be sure of a correct amount if everyone used a measuring can according to his own standard of measurement? 2. Andre Ampere's contribution to electricity.
		1. How many nations have contributed to our present-day knowledge of electricity?
	1. Look up the root meanings of insulator and conductor in a dictionary.	1. If "con" and "insula" are Latin words, can you see any value for Latin in school?

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
F. Do Experiment on page 6-1 (series circuit).	1. What is the main feature of a series circuit?	
G. Do Experiment No. 7 starting on page 6-5.	1. How does a parallel circuit differ from a series circuit?	1. How many parallel paths are possible in a parallel circuit?
H. From F and G above, show that the sum of the voltage drops across the two lamps equals the applied E. Let students measure for themselves. Measure total and branch currents. Relate Kirchhoff's two laws.	1. Kirchhoff's laws in effect say, "You can't get out more than you've put in." Explain this to students.	1. Discuss "Law of Conservation of Energy" if time allows. 2. Discuss Ohm's law.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. If one lamp draws one amp., what do you predict five lamps of the same value would draw?	1. Write a simple definition of a series circuit.	
1. If one lamp in a parallel circuit caused one amp. to flow from the source, what do you predict five similar lamps would draw?	1. Write a description of a parallel circuit.	1. Would you rather live in a city with all series circuits or in a city with all parallel circuits for your house lighting? Why?
1. A series circuit consists of five. 2. Give several simple problems in Ohm's law. a. Simple series b. Simple parallel	1. How do Kirchhoff's laws apply to a bank?	

III. APPLICATION

A. The electrician should be adept at reading meters and interpreting the results of these readings. Generally, the electrician is more involved with parallel circuits than he is with series circuits, but a knowledge of both is required in the trade. Kirchhoff's laws are applied in their daily work--especially the current law.

IV. EVALUATION CRITERIA GUIDELINE

A. Define one volt.

B. Define one ampere.

C. Define one ohm.

D. What are the characteristics of a series circuit?

E. What are the characteristics of a parallel circuit?

F. What is Kirchhoff's law for voltage?

G. What is Kirchhoff's law for current?

H. A voltmeter is placed in _____ with the device to be measured.

I. An ammeter is placed in _____ with a device to be measured.

J. State Ohm's law.

V. SUMMARY

A. One volt is defined as the amount of electrical pressure necessary to force one ampere of current through a resistance of one ohm.

B. One ampere is defined as that amount of current which will flow when one volt is impressed across a resistance of one ohm.

C. One ohm is that amount of resistance which will permit one ampere of current to flow when one volt is impressed across it.

D. A simple circuit consists of a power source, a load, a complete current path and a control device (switch).

E. A series circuit is characterized by the fact that there is only one current which flows through every element in the circuit. If this path is broken, all elements are inoperative.

F. A parallel circuit can consist of many branches with each branch drawing an amount of current depending on the resistance of the branch. If one branch opens, the other branches are not affected. Each branch of a parallel circuit has the same voltage applied to it.

G. Kirchhoff's law for voltage states that: The sum of the voltage drops in the external circuit is equal to the applied voltage.

H. Kirchhoff's law for current states that: The sum of the currents that leave a junction is equal to the sum of the currents that entered the junction.

VI. SUGGESTED TIME AND SEQUENCE LISTING

10 minutes -- Introduction

20 minutes -- Explanation of 555 Exploratory Lab

15 minutes -- Meter reading

255 minutes -- Lab experiences and experiment in the order given under II above

60 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 7
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Electrical Materials, Overcurrent Devices and Simple Construction

AIM:

To familiarize the student with the names and uses of basic electrical devices, to reinforce the concepts of simple circuitry from Lessons 5 and 6, and the uses and types of overcurrent devices. Simple construction practice and layout.

INSTRUCTIONAL AIDS:

For each two students: One 2-1/2' x 4' x 3/4" plywood "breadboard," four cleat-type receptacles, three 7-1/2 W. lamps, one toggle switch with box, one 5 amp. plug-type fuse, tools, and hardware necessary to build complete series circuit. Switches as necessary.

EQUIPMENT:

Chalkboard, etc.

PRIMARY REFERENCES:

1) Exploratory Electronics, Farmingdale, New Jersey: Buck Engineering Company, Inc., 1970.

2) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Today, we will put into practice some of the principles learned in previous lessons. Shortly, you will build a series circuit from a drawing I will put on the board. Discuss safety; and, also enjoin students from plugging their

completed circuits into power source (wall receptacle) until inspected by instructor. Draw and discuss simple series circuit. Mention application of Ohm's and Kirchhoff's laws.

B. Have students turn to Experience No. 14 on page 14-1. Discuss.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Issue equipment to construct series circuit.	1. In series circuit, all units conduct same current. 2. Discuss wattage.	1. Voltage drop across each unit is a function of the resistance. 2. Watts = Volts x Amps. 3. Demonstrate the lower resistance of lamps with higher wattage ratings.
B. After completion of above, issue Simpson 260 VOM. Have students check applied voltage and drops across each lamp. Add sum of drops and compare with applied voltage.	1. Discuss Simpson 260 in terms of AC voltage made. Can you read AC current on the 260?	1. Special means are needed to read AC current. See math section for one way it can be done.
C. Using equipment from A (above), have students construct parallel circuits.	1. Lamps all now grow brighter than when connected in series. Why? 2. In a parallel circuit, all elements have the same voltage applied. 3. Discuss Experience No. 15 on pages 15-1 to 15-6 in Lab-Volt Exploratory Electronics.	1. The amount of light is a function of current which is a function of resistance and voltage. a. Compare the result of using different watt bulbs in a series circuit as compared to a parallel circuit. b. Compare the effect of unscrewing a bulb in a series to what happens in a parallel circuit.
D. Hook up 3-way switch using Lab-Volt 555 Experience No. 9 (p. 9-1). 1. Wire up some 3-way switches as shown on pages 65 to 69 in Richter's Practical Electrical Wiring.	1. Discuss the nature and need of "traveler" wires in 3-way switching.	
E. Discuss the various types of overcurrent devices as shown in Chapter 5 (p. 75-) in Richter's Practical Electrical Wiring as time allows.	1. Need for fuses and other overcurrent devices.	1. List some fusible materials. How do they differ in "feel" when compared to a piece of copper or steel of the same diameter? What is the one characteristic necessary in a fuse?

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. A series circuit consists of: a 30 ohm unit, a 12 ohm unit, a 60 unit and a 24 ohm unit. The current is 1.2 amps. What is the applied voltage? How does the drop across the 60 ohm unit compare with the drop across the 30 ohm unit? Why?	1. Explain the meaning of "voltage drop." 2. Discuss applied voltage as "internal" voltage and voltage drops as "external" voltage.	1. .Contributions of James Watt and Thomas Edison to electrical progress.
1. Watts = E x I. According to measured voltage, each lamp drops about the amount of applied voltage divided by three. What is the circuit current?	1. How to look up "Life of Kirchhoff." Reading and oral report can be assigned.	1. Suppose each country kept each scientific breakthrough as a national secret. Would the U. S. be a world leader? Would the Soviets have an atom bomb?
1. 121 volts is applied to a parallel circuit, a 10-watt lamp, a 50-watt lamp, and a 100-watt lamp. Can you calculate the current through the lamp? How much current does the 100-watt lamp draw? 2. What is the resistance of the 100-watt lamp?	1. Look up the word "ampacity" on p. 75 in Richter's Practical Electrical Wiring.	1. What would be the effect on a city if all electrical wires were in the ground rather than on telephone poles? 2. Would it cost more or less to put all conductors underground? What would this do to the present cost of home electricity?
1. If a 3-way switch costs $1.25 and a 4-way switch costs $1.75, what is the total cost of seven 3-way switches and four 4-way switches?		1. Early discovery and development of fusing.
1. A fuse costs about 10¢. In an emergency, people have been known to insert a penny. Is this an economical and practical way to save 9¢? A fuse costs 10¢; a circuit breaker costs about $1.50. Which costs the most in the long run?	1. Write a letter to Allstate Insurance Company, Chicago, Ill. Ask them of their policyholders only, how many electrical fires are caused by poor fusing practices.	1. How many fires are produced in American homes annually because of faulty or improper fusing systems? How does this offset the insurance rate?

III. APPLICATION

A. Student will be involved in the actual construction of simple series and parallel circuits. In addition, they will reinforce their knowledge of the principles of Ohm's and Kirchhoff's laws. The student will see the bare elements in three-way switching and apply the knowledge of "travelers" to their construction. Also, fuses and fusing are an integral part of a practical electrician's knowledge. In this lesson, some of the various overcurrent devices are shown and explained. The student has a chance to use them and see their practical and safety values.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the difference between an electrical lamp and a light bulb.

B. What is a "cleat" receptacle?

C. What is a "knife" switch?

D. What is a toggle switch?

E. Why is a toggle switch usually housed in a switch box?

F. What happens to the intensity of light when lamps are placed in series?

G. Why do all lights in a series string go out when one of the lamps is removed?

H. What is the main characteristic of a parallel circuit?

I. Make a drawing of a three-way switch using two single pole double-throw knife switches.

J. What is meant by a "traveler"?

K. Why is it wise to fuse every circuit?

L. What is a "fuse"?

M. What is a circuit breaker?

N. A penny is "cheap." Is it wise to use a penny in place of a plug fuse?

O. How does the NEC code define a circuit breaker? (Hint: See Richter, Practical Electrical Wiring, p. 83.)

V. SUMMARY

A. When lamps are connected in series, the brightness of each drops because the current is reduced. When lamps are placed in parallel, the brightness remains the same regardless of the number of lamps in parallel.

B. In the series circuit, when one lamp is removed, all go out because the current path is broken. In the parallel circuit, if one lamp goes out, the remainder stay lit because the other units are still supplied with power.

C. The wires that start at one switch in a three-way switching circuit and terminate at the other switch are called "travelers."

D. Overcurrent devices or fuses are devices or units that melt or "trip" under various conditions of raised temperatures. Fuses are used to prevent fires due to "overload." Ampacity refers to the number of amperes of current a wire can carry continuously. The NEC code defines wire ampacities.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Motivation and material handouts

60 minutes -- Series circuit

60 minutes -- Parallel circuit

120 minutes -- Completion of construction

40 minutes -- Discussion, examination, and demonstration of overcurrent devices; ampacity

50 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Gerrish, H. H., Learning Experiences in Electricity, Farmingdale, New Jersey: Buck Engineering Company, Inc., 1970.

INSTRUCTOR'S UNIT PLAN

Unit 8
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Basic Electricity (AC)--Terminology, Nature, Values in Single-Phase

AIM:

To introduce the concepts of alternating current and show the student how it differs from direct current. To teach the student the useful terminology of alternating current as used in the electrical trades so that it becomes a part of his useful vocabulary. To demonstrate to the student how alternating current is generated, show the reality of the sine wave on an oscilloscope, to have the student learn the characteristics of alternating current, and to teach the student the different values of alternating current and how they compare to DC. All of the above to pertain to single-phase AC.

INSTRUCTIONAL AIDS:

Film - Radio Technician Training--Inductance--Parts 1 and 2--How Magnetic Force Reacts Around a Coil, NOB Philadelphia: Navy Film MN-1540B (36 minutes).

Transparencies - BEV111 Alternating Current Unit, McCloud, Minn.: Instruct-A-Kits, Dansen Manufacturing Company, Inc., Cooper at First, Box 70.

EQUIPMENT:

One oscilloscope (if no oscilloscope, a Simpson 311 VTUM can be used to measure peak-to-peak voltage).

Sound film projector, overhead projector, screen.

Simpson 260 VOM.

Chalkboard, etc.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Show sine wave-form and DC wave-form on oscilloscope. Discuss what is meant by DC and AC as it applies to an automobile ignition system. But an auto spark is weak and lacks power. How pulsating DC is generated in auto. Let's see how we generate AC for home use that has power to light lights, run sweepers, and keep foods fresh.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Show slide BEV111-1: Comparison of DC and AC Voltages.	1. On chalkboard, show DC as unidirectional and essentially at a constant level. For AC, keep reversing power supply polarity. This gives a square wave.	1. On board, again show N-S poles of magnet and show how a single coil of wire cuts a magnetic field to produce an alternating current or a sine wave of current. 2. The above can be demonstrated with a coil and a magnet.
B. Show slide BEV111-2: Frequency and Amplitude.	1. Amplitude means "how high or how strong." Compare to a person on a swing. 2. Frequency means "how many per unit of time." Compare 60 cps with 1 MC on the radio dial.	1. Explain "instantaneous" values in the AC cycle. 2. Explain what is meant by single phase.
C. Demonstrate a single sine wave on the oscilloscope. Point out the peak-to-peak value. Measure the AC voltage with the Simpson 260. Measure the p-p voltage with the VTUM.	1. The AC voltmeter measures RMS voltage. Older VM's measure average value of AC. Explain p-p, average, and RMS values.	1. AC meters have rectifiers and pass only 1/2 cycle. Thus, the Simpson reads average voltage but is calibrated in RMS value. 2. Discuss and demonstrate the production of pulsating direct current from AC current. 3. Discuss possibility of frequency other than 60 cycles/second. a. Effect of varying cycles b. Standards in other countries
D. Show film: How Magnetic Force Reacts Around a Coil (36 minutes). 1. Discuss the constant changing of the magnetic field when AC is applied to a coil.		
E. Let students take some AC readings with the Simpson 260.	1. Teach safety rules in how to hold probes with tips of fingers. Also teach "one hand in left pocket" safety rule.	1. Discuss that all meters are essentially DC meters and that on AC mode, a rectifier must be used to convert AC to DC.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
	1. Look up word "sine" in dictionary. Which meaning applies to AC?	
1. $f = \frac{1}{T}$. In a 60 cps sine wave, how often does a single cycle occur? 2. Show BEV111-5: Phases.	1. Look up the word "amplitude" in the dictionary. From what language did it originate?	1. Nicola Tesla can probably be considered as the "father of AC." See if the library has any one of the numerous "Life of Tesla" books. A most interesting story.
1. On a VTUM, a sine wave measures 369 V p-p. What is the RMS value? The average value? a. RMS = .707E max b. AVE = .637E max	1. Read to discover what is the practical value of an RMS voltage or current. How does it compare with DC?	1. You see many appliances marked 110-120 VAC. What does this mean?
1. Rig up a single series circuit of 5 or 6 units and show that Kirchhoff's law holds for AC resistive circuits.	1. Have students develop a paragraph describing life in a world with only AC or only DC power. 2. Have them share their viewpoints and discuss the values of each.	1. History of magnets.
1. Let students do several problems in Kirchhoff's law on AC series circuits consisting of 5 or 6 resistors over 2000 ohms each.		

III. APPLICATION

A. Electrical workers must have an understanding of peak-to-peak values, RMS values, average values, and instantaneous values of alternating current. They should also be familiar with frequency and amplitude of periodic waves. In addition, a knowledge of the magnetic fields and related phenomena that accompany the flow of current through a wire is required.

IV. EVALUATION CRITERIA GUIDELINE

A. Is the magnetic field that surrounds a current-carrying wire useful or harmful?

B. What is instantaneous voltage?

C. Draw a sine wave.

D. Is the sine wave the same as a half-circle?

E. What is RMS voltage?

F. What is peak-to-peak voltage?

G. What voltage does a VOM measure when placed across the AC line?

H. If you must hold a voltage probe, why is it a good idea to put the left hand in your pocket?

V. SUMMARY

A. Alternating current is a current that is always changing from zero through a positive maximum and back to zero. From here it goes through a negative maxim and back to zero. This is called "one cycle." DC is of a constant value at all times. Because a VOM reads "averages," a rectifier is used to pass only positive half-cycles. Thus, it reads average voltage or RMS voltage. RMS voltage is that value of AC voltage which will produce the same heating effect as a given DC voltage.

VI. SUGGESTED TIME AND SEQUENCE LISTING

20 minutes -- Introduction and motivation

280 minutes -- Presentation of slides, film and discussion of instructional topics A through E

60 minutes -- Evaluation and testing

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Exploratory Electronics, Farmingdale, New Jersey: Buck Engineering Company, Inc., 1970

2) Mileaf, Harry et al., Electricity One-Seven, New York: Hayden Book Company, Inc., 1969.

INSTRUCTOR'S UNIT PLAN

Unit 9
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Basic Electricity (AC) and Basic Circuits--R, C, and L

AIM:

To familiarize the students with the effects of resistance, inductance, and capacitance on voltage and current phase relationships in AC. RCL in series circuits and RCL in parallel circuits. Discussion of 3-phase AC.

INSTRUCTIONAL AIDS:

Transparencies - BEV111 Alternating Current Unit, McCloud, Minn.: Instruct-A-Kits, Dansen Manufacturing Company, Inc., Cooper at First, Box 70.

Films - U. S. Navy, NOB, Philadelphia:
MN-8018A - Basic Electricity--Inductance in AC Circuits (7 minutes)
MN-8018B - Basic Electricity--Capacitance in AC Circuits (6 minutes)
MN-8018C - Basic Electricity--AC Series Circuits (6 minutes)
MN-8018D - Basic Electricity--AC Parallel Circuits (6 minutes)

EQUIPMENT:

Overhead projector, sound motion picture projector, screen, chalkboard, etc.

Simpson 260 VOM.

PRIMARY REFERENCES:

1) Mileaf, Harry et al., Electricity One-Seven, New York: Hayden Book Company, Inc., 1969.

I. INTRODUCTION AND MOTIVATION

A. As you already know, there are some fundamental differences between alternating and direct current. Yet, in many ways, both are capable of doing the same things: produce heat, light, run motors, etc. In today's lesson you will see what happens when an alternating current source is terminated in a purely resistive load, a purely inductive load and a purely capacitive load. In addition, you will see the effect on current and voltage phases when resistance is introduced into a purely inductive or a purely capacitive circuit. Of great interest will be the effect of combining both inductive and capacitive elements into series and parallel combinations.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Show slide BEV111-6: Inductance in AC Circuits. 1. Show film MN-8018A: Inductance.	1. An inductance in its simplest form is merely a straight piece of wire wrapped on a cylindrical form.	1. The longer the coil, the more the inductance. The closer the turns are placed together, the more the inductance. The magnetic field that surrounds one turn of wire cuts through adjacent turns of wire. 2. Students can build their own inductance coils and study effects of numbers of turns. a. Caution--use safe current levels b. Use coils to step-up or step-down voltage
B. Show BEV111-5: Phases. 1. Discuss phase relationships in a purely resistive circuit.	1. Voltage and current are "in phase."	
C. Show slide BEV111-7: Capacitance in AC Circuits. 1. Discuss impedance: a. Resistance b. Reactance 1) Inductive 2) Capacitive 2. Show film MN-8018B: Capacitance.	1. Simplest capacitor is made of two plates which are separated by air or other "dielectric" material. 2. A capacitor is considered to be a storage tank for electrons, the same as a gasoline tank stores gasoline.	1. Closer spacing = more capacity. 2. Further spacing = less capacity. 3. Absence of electrons = positive charge. 4. Excess of electrons = negative charge. 5. Students can demonstrate the capacitor's ability to store charge using static electricity.
D. Show slide BEV111-8. RCL in AC Series Circuits. 1. Show film MN-8018C: AC Series Circuits.	1. Discuss series circuits. Mention that sum of E drops is not equal to applied E.	1. Explain to students why a circuit cannot be capacitive and reactive at the same time.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Inductances in series are additive. a. $L_T = L_1 + L_2$, etc.		1. Coil winding, like brick-making, is a specialized occupation. See how many coil winding companies are located in your hometown. 2. Michael Faraday. a. Principle of electro-magnetic induction b. Existence of electrons 3. Industrial processes now using Faraday's law.
1. Discuss circle as 360° unit. Roll this circle along a straight line and mark line each 15° as circle rolls. Discuss circular and linear degrees. 2. Show film MN-8018A: Basic Electricity--Inductance.	1. Look up word "linear" in dictionary. How does linear relate to circular?	
1. Capacitors in parallel are additive. a. $C_T = C_1 + C_2$, etc. 2. Unit of capacitance is the farad.	1. What is the difference between capacity, capacitance, and capacitor? 2. A capacitor was once called a condenser. Why?	
1. Give simple demonstration in voltage triangle that when components are "out of phase" they are not added algebraically, but are added vectorially.		1. We are indebted to the Ancient Greeks for many things. Electricians owe a great debt to Pythagoras. Who was he? What is his claim to fame? How do we use his discovery?

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
E. Show slide BEV111-9: RCL in AC Parallel Circuits. 1. Show film: MN-8018D: AC Parallel Circuits.	1. Discuss parallel circuits.	
F. Discuss 3-phase electrical voltages and currents.		

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. To calculate frequency, the following formula is used: $f = \frac{1}{2\pi\sqrt{LC}}$ a. Note that resistance does not enter into the calculation 2. Discuss that the square root of a number is one of the two equal factors of a number. If class is mathematically capable, teach extraction of square root, etc.	1. Discuss resonance. Use example of two tuning forks of same frequency. Resonance can be thought of as that frequency at which an RCL circuit "vibrates" electrically. What implications does resonance have beyond electrical?	1. All radios and TV's use the principle of "resonance" when tuning from station to station. Discuss.

III. APPLICATION

A. All electrical workers must have a knowledge of the effect of resistance, inductance, and capacitance in the AC circuit. He must also know the effects that these basic components have singly and in combination. This knowledge is particularly useful in power generating stations when generators are placed in parallel on the line. This knowledge will also be applied in the next lesson on magnetism and transformers.

IV. EVALUATION CRITERIA GUIDELINE

A. Describe a simple inductor.

B. Describe a simple capacitor.

C. Define impedance.

D. Define reactance.

E. In an inductive circuit, the current _____ the voltage by 90°.

F. In a capacitive circuit, the current _____ the voltage by 90°.

G. Why isn't it possible to simply add the voltage readings in an RL circuit?

H. What is resonance?

I. What is meant by "in" phase?

J. What is meant by "out of" phase?

V. SUMMARY

A. An inductor is simply a piece of wire wound on a cylindrical form. A capacitor in its simplest form is simply two pieces of metal separated by an air space or other dielectric. An inductance causes the current to lag the voltage by 90°. A capacitor causes the current to lead the applied voltage by 90° Impedance is the total opposition offered the flow of current in the AC circuit. It is composed of resistance, inductive reactance and capacitive reactance. A circuit cannot be inductive and capacitive at the same time because they exert opposing forces and are subtractive. The circuit takes on the characteristic of the stronger force. When $X_L = X_C$ they cancel and the circuit becomes purely resistive. This is a particular condition known as "resonance."

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Introduction and motivation

60 minutes -- Inductance

60 minutes -- Capacitance

60 minutes -- Series AC circuit

60 minutes -- Parallel AC circuit

60 minutes -- Vocabulary enrichment, resonance, Pythagoras, vectors, phasers, etc.; impedance, reactance and AC resistance

45 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Levine, S., Vocational and Technical Mathematics in Action, New York: Hayden Book Company, Inc., 1969.

2) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

INSTRUCTOR'S UNIT PLAN

Unit 10
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Magnetism and Transformers

AIM:

To involve the student in the study of magnetism as it applies alone, is used in the generation of electrical currents, to show how magnetic fields can be rotated, to present the theory of how DC motors work, and to present the operational theory of AC motors and generators.

To supplement the above, the student will be taught and be given an opportunity to test on "ring out" transformers. To install a circuit breaker panel.

INSTRUCTIONAL AIDS:

Films - U. S. Navy, NOB, Philadelphia:
MA-2333A, Part 1--Elements of Electricity and Magnetism (13 minutes)
MN-8016D, Basic Electricity--Electromagnets (2 minutes)
MN-8594B, DC Motors--Theory of Operation (10 minutes)
MC-7356, Commutation of DC Machines (24 minutes)
ME-6028, Electrical Work--Electrical Machinery--Rotating Magnetic Fields (13 minutes)
MA-9697B, Motors and Generators--Part 2--AC Motors and Generators (25 minutes)

EQUIPMENT:

Sound motion picture projector, screen, chalkboard, etc.

Lab-Volt 555, Exploratory Electronics Lab., Simpson 260 VOM, ten discarded transformers for each two students (some faulty ones included).

PRIMARY REFERENCES:

1) Exploratory Electronics, Farmingdale, New Jersey: Buck Engineering Company, Inc., 1970.

I. INTRODUCTION AND MOTIVATION

A. Select one of the films above and show it to the students at the beginning of the period. See if the students can develop the concept of magnetism and its application in motors, generators, and other electrical units.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Discuss earth's magnetism and compasses. 1. Show film MA-2333A. 2. Show film MN-8016D. 3. Discuss.	1. North Pole on a magnet is really the South Pole. (Earth's North Pole is reference point for all magnets.)	1. Unlikes attract; likes repel. Thus, on a compass, the N Pole is really the "North-seeking" Pole; hence, South Pole. 2. Create an electric current using a magnet and coil as a classroom demonstration.
B. Do Experiment No. 3, p. 3-1 (Production Electricity Through Magnetism) on Lab-Volt 555 Work Station. 1. Do Experiment No. 18 on p. 18-1 on Lab-Volt 555 Exploratory Unit. 2. Do Experiment No. 19 on p. 19-1 on Lab-Volt 555 Exploratory Unit.	1. Discuss answers to questions with students. 2. Discuss Experiment No. 18 with students. 3. Discuss Experiment No. 19 with students.	1. Be sure to stress that current flows in the wire when either the magnet or the coil is moved. 2. How is the strength of the magnetic field related to the meter deflection? 3. How can you convert a relay into a bell?
C. Show film MN-8594B: Theory of Operation of DC Machines. 1. Discuss.		1. Discuss magnetic repulsion principle. 2. Students can construct and experiment with electromagnets.
D. Show film MN-7356: DC Commutation.		
E. Hand out transformers (10 to each two students); VOM (1 to each two students. 1. Demonstrate how to take resistance readings with VOM.	1. Discuss types of transformers, color coding of leads, and relative resistance of windings. Step-up, step-down, and isolation.	1. Discuss magnetic induction. Is an AC device and will not work on DC.
F. Show film ME-6028: Rotating Magnetic Fields. 1. Show film MA-9697B: AC Motors and Generators.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
		1. If there were no magnetic lines of force surrounding the earth, what effect do you think this would have had on history? 2. Influence on exploration and discovery.
	1. Look up the word "lodestone" in the dictionary. 2. Find references to the term in fiction books. 3. Draw a relay on the board and show how it can be converted to a buzzer.	1. What was the form of the very first magnet known to man? 2. Where was it found? 3. How can a buzzer be used as a means of word communication?
1. How does the word "commutative" apply to both mathematics and to electrical DC generators?	1. Look up the difference between "commutation" on AC and DC generators.	1. Why are "slip rings" necessary on AC generators?
1. If time allows, show mathematical relationship between turns ratio and voltage. $\frac{N_p}{N_s} = \frac{E_p}{E_s}$ + also $P_{pri} = P_{sec}$ (Do several illustrative problems) 2. Students can build transformers and then measure the actual change in voltage.		1. The transformer is probably the most efficient device known to man! What would be the gas mileage on a typical car if the gas engine was as efficient as the transformer? 2. What effect would this have ecologically speaking?

III. APPLICATION

A. Students will learn the importance of magnetism both fixed and rotating fields. Instructor should emphasize the many uses of magnetic principles in the electrical trades. The students will be involved in testing transformers for opens, shorts and turns ratios. In addition, students will view two enrichment films: on rotating magnetic fields, and on AC motors and generators.

IV. EVALUATION CRITERIA GUIDELINE

A. What is a North Pole on a compass?

B. Like poles _____ each other.

C. Unlike poles _____ each other.

D. What is magnetic induction?

E. What is a relay?

F. What is the principle of operation of a relay?

G. What is a transformer?

H. Draw the schematic representation for an iron-core transformer.

I. Current can be produced in a coil by moving the _____ or by moving the _____.

J. What is the "commutator" on an AC generator called?

V. SUMMARY

A. The North Pole on a magnetic compass points North--it is thus really a South Pole. An electromagnet is the magnet that is created when an electrical current passes through a coil. Electrical motors work on the magnetic repulsion principle. A transformer generally consists of two or more windings on a common core or a yoke. Transformers are generally of three types--isolation, step-up, and step-down. Step-up means that the secondary voltage is greater than the primary voltage. The transformer is 95-98% efficient.

VI. SUGGESTED TIME AND SEQUENCE LISTING

10 minutes -- Introduction and motivation

300 minutes -- Sequence topics A_1 to F_2.

50 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Mileaf, Harry et al., Electricity One-Seven, New York: Hayden Book Company, Inc., 1969.

2) Transparencies, BE1V: Magnetism Unit, Instruct-A-Kits, Dansen Mfg. Co., Inc., Cooper at First, Box 70, St. Cloud, Minn. 56301.

INSTRUCTOR'S UNIT PLAN

Unit 11
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Service Entrance and Branch Circuits

AIM:

To help the student develop an elementary knowledge of how to plan and install a service entrance and how to calculate simple branch circuits.

INSTRUCTIONAL AIDS:

Film - A Family Affair, Philadelphia: Westinghouse Electric Corporation, 3001 Walnut Street.

Booklet - F5428, Chicago: Sears, Roebuck and Company, Rev. 11-69.

EQUIPMENT:

Sound motion picture projector, screen.

For each two students: Two 5' x 5' rooms back-to-back made of 2" x 4" building materials, 6' high, plywood mount for fuse panel (a breaker cabinet with six branch circuits will be used); one fuse panel, six circuit breakers, and tools necessary to drill studs, mount panel, etc.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. All of the preceding lessons were designed to give you background knowledge, vocabulary, and some expertise in matters electrical. Today, we will begin to learn some of

the factors that go into the intelligent planning of home wiring. First, you will see a film about inadequate house wiring.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Show film: A Family Affair (24 minutes).	1. Discuss some of the problems in the family that relate directly to inadequate wiring.	
B. Wire sizes: AWG and B&S gauge. 1. Circular mils. 2. Wire colors: a. 2-wire--black and white b. 3-wire--black, white, red c. 4-wire--black, white, red, blue, etc. 3. Insulation: rubber, plastic. a. See NEC code book for kinds of wires to use in different locations (ART 100)	1. #14 wire most commonly used in house wiring; dia. = 64 mils.	1. Wires of smaller diameter have larger number, e.g., #40 = .003 inch. Thus, #10 wire has a larger diameter than #14. 2. Students can estimate wire sizes and check estimates by using wire gauges. 3. Students may examine various types of wire.
C. Reasons for selection of proper wire sizes: 1. Low voltage drop. 2. Need for proper voltage. 3. Wattage--not voltage consideration.		1. Study principle of grounding.
D. Grounding. 1. Means "neutral" wire. 2. Connected to ground. 3. Grounded equipment ground wire carries no current. 4. White wire is neutral wire.	1. Degree of shock will depend on surface on which you stand. Damp or wet may be fatal.	1. Explain and study effects of grounds, Figs. 9-2, 9-3, 9-4, 9-5, pages 134-135 in Practical Electrical Wiring by H. P. Richter. Also see pages 136-137.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Students may calculate the floor area for typical rooms and determine the proper number of circuits required. 2. Students can develop charts to reflect the proper wire sizes suitable for various wattage loads.	1. Review basic parts of speech in Warriner's Handbook or similar text.	1. Can you think of any more problems that might arise in your home due to an inadequate electrical supply? 2. Housing controls: a. Building codes b. Housing codes
	1. See Practical Electrical Wiring textbook by Richter. Read "How Dangerous Are Shocks?" p. 141.	
	1. Find out what is meant by a "continuous ground."	

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
E. Discuss with class: 1. "Wiring Principles and Planning," p. 1-9 in Sears, Roebuck's Simplified Electric Wiring Handbook. 2. Study carefully the wattages of different house circuits, fusing, service entrance, fuse panel, etc.	1. Advantages of numerous branch circuits. 2. Floor area determines number of circuits. 3. Special appliance circuits. a. Small appliances 4. Types of branch circuits.	1. What is a "single current consuming" device? 2. Ordinary circuit of two or more outlets. 3. Does the "code" place a limit on the number of outlets per circuit?
F. Calculate a 2,000 sq.ft. house. 1. Use outline on p. 205 of Richter's Practical Electrical Wiring. 2. Discuss with students what happens because of number of circuits and also what must be preplanned for later installation of 12 kw electric range and a 1.5 kw bathroom heater.	1. Impress on the student the value of using the NEC code book as a "bible."	
G. Begin installation of fuse panel on "5 x 5 room" nearest the service drop.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. You have a 115/230 V service with a neutral wire (naturally). You have a total load of approximately 2000 amps. How would you divide the load? Draw a picture.	1. What is a "service drop?" a. Hint: See Richter, p. 199-200 2. What is a demand factor? See NEC code book, Sec. 220-4(a).	

III. APPLICATION

A. Students will be involved in studying and then planning the installation of a service entrance and then help plan a branch circuit. Students will install a fuse panel for later work.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the first consideration in determining the number of branch circuits?

B. What is a ground?

C. Name two types of grounds.

D. What is the most common wire by number used in house wiring?

E. What is the maximum wattage of the usual electric range?

F. What is a "branch" circuit?

G. Name the colors in 2, 3, and 4-wire cables or cords.

H. What is the color of the neutral or grounded wire?

I. What should be done to motors to make them safe to handle?

J. What is the most dangerous surface to stand on when you are handling electrical equipment?

K. For proper operation of a piece of electrical equipment, which is more important: voltage or wattage?

V. SUMMARY

A. Inadequate house wiring can be dangerous, troublesome, and unreliable. Number 14 wire has an ampacity of 15 amps. and is most used wire size in house wiring.

B. Wires in cables or cords are color coded: 2-wire--white and black; 3-wire--white, black, red; 4-wire--white, black, red, blue.

C. The white wire is the neutral or ground wire.

D. Wires must be selected for size to keep the line drop low since electrical devices operate best with rated voltage applied. Wattage is a more important consideration than voltage in sizing wire.

E. Ground means "neutral." There are two general types of grounds--line or electrical ground and equipment ground.

F. The NEC code book is the "bible" of all electricians because while local ordinances may occasionally prevail, the NEC code book abounds with safe and tested practices. Calculation of electrical services and branch circuits looks easy but there must always be some thought given to "future needs."

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Film and introduction and motivation

90 minutes -- Wire sizes, wire colors, insulation, selection of wire sizes, and grounding

90 minutes -- Study of circuits in Sears Handbook and calculations

110 minutes -- Installation of fuse panel

40 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Graham, K. C., Interior Electric Wiring, Chicago: American Technical Society, 1963 or later.

INSTRUCTOR'S UNIT PLAN

Unit 12
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Design and Wiring of Simple AC Circuits

AIM:

To teach the student how to calculate the amperage required for a 10' x 12' room with one 3/4 hp air conditioner. To involve the student in the design and installation of a single circuit breaker box with supply 115/230 V. six circuit breakers.

INSTRUCTIONAL AIDS:

Booklet - F5428, Chicago: Sears, Roebuck and Company, Rev. 11-69.

EQUIPMENT:

Braidex, staples, outlet boxes, ceiling outlet box, light switch, junction boxes, tools, and equipment necessary to complete job.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Yesterday you learned something about the factors that go into the calculation of the amperages demanded by a house wired for electrical power. You also installed a circuit breaker panel. Today, we will review the calculation and each one of you will calculate and install a simple circuit. As of now, you have a service drop supplying 115/230 V. and your circuit breaker cabinet is installed. Now we are ready to do a single room 10' x 12' with an air conditioner to be permanently installed.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Before we go any further, review code Sec. 230, "Services." 1. Draw simple schematic of room showing location of all outlets. Schematic symbols to use: panel box, ceiling outlet, convenience outlet, special purpose outlet, etc.	1. Sec. 230-71, "Rating of Service Entrances." 2. Sec. 230-72, "Connections to Terminals." 3. Sec. 230-70, "Disconnections from Service Conductors." 4. Sec. 230-92, "Location of Branch Circuit Over-Current Devices."	1. The NEC code is based on safety and not on convenience or economy. Discuss.
B. Calculate amperage required by 12' x 10' room after review under Math B. Do math <u>first</u>.	1. Discuss effects of wire length.	1. What is meant by "line drop"?
C. Review grounding. See NEC code Sec. 210-7, "Grounding Receptacles." 1. See Sec. 200-2, "General." 2. Is your panel cabinet properly grounded?	1. What is the color of the ground conductor in a cable? Any exceptions?	1. How is a ground made continuous past a water meter? 2. Are there any exceptions for grounding? (Sec. 200-2)
D. Selection of wire sizes to be used. 1. Selection of CB sizes.	1. Ampacity depends on: a. Wire size b. Type of insulation c. Wet or dry location, etc.	1. Why are ampacity tables usually based on copper wire? 2. Why is copper a good conductor? a. Relate conductivity to atomic structure b. Compare copper to other conductors
E. Identify all parts to be used in wiring the 10' x 12' room.	1. Discuss construction practices and obstacles.	1. Discuss how load is split in 115/230 system.
F. Wire room.	1. Keep reviewing the NEC code.	1. Study Sears, Roebuck & Company booklet; especially see page 15 for a basic system in simple form.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
		1. Which is more important? Safety or economy? 2. National Electrical Code--established 1897.
1. Do a calculation for a 3000 sq.ft. house. 2. Review "Demand Factor." 3. Problem: A room is 12' x 10'. It is to be lighted at 3-watts and a 1/2 hp air conditioner is to be permanently installed. Calculate the amperage required.	1. Write a letter to Carrier Corporation, Spruce Street, Trenton, New Jersey 08638. Seek information on types, demands, and installation suggestions of home air conditioners.	1. What do you think the result of installing air conditioners in office buildings has been on personnel efficiency? 2. Old people tend to prefer rooms that are not air conditioned. Any reasons?
	1. See NEC code book on maximum number of wires permitted in an electrical outlet box according to size.	1. If mankind ran out of copper, what would be the next cheapest material to use? Is it more or less plentiful than copper?
1. Calculate the total cost of materials.		
1. Assume that you are receiving an apprentice's pay of $4.70 per hour. Note the time you started. Note the time of completion. What is the labor cost?		1. Many people do not update their home wiring because of the prohibitive cost. What can you, as an electrician, do to bring costs down? You could work longer at a lower wage. What is the trend?

III. APPLICATION

A. This is a series of steps often taken by an electrician in order to bid on a job. In addition, before an apprentice gets out of his "time" he must be familiar with NEC codes. The wiring of a circuit breaker panel is one of the important jobs an electrician is required to master. Also, he must be familiar with splitting loads, mounting receptacles and boxes, running wires, and preplanning every move.

IV. EVALUATION CRITERIA GUIDELINE

A. Find in the NEC code book the maximum number of conductors that is permitted in an outlet box 4" x 1-1/2" square.

B. What is the color of a neutral or ground wire?

C. What is a ground rod?

D. For good lighting, what is the usual watts/sq.ft. used?

E. What is a "lock nut"?

F. What is a circuit breaker?

G. What is the main factor to be considered in the calculation of adequate lighting?

H. What is ampacity?

I. The NEC code is based on _____.

J. What is "live drop"?

K. Generally speaking, what does "load distribution" mean?

V. SUMMARY

A. A service drop consists of the wires that leave a pole and enter a dwelling. A circuit breaker panel is a metallic box containing overcurrent devices or circuit breakers. The ampacity of wire depends on wire size, insulation, location, etc. The number of amperes/sq.ft. is generally considered as three amperes for adequate lighting. Electrical circuits must have one continuous ground wire except in cases specifically mentioned in the NEC code. The NEC code is based on safety and not on convenience or economy.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Introduction and motivation

90 minutes -- Calculation practice, wire sizes selection, etc.

30 minutes -- Review and discussion of grounds and grounding

185 minutes -- Construction and installation

40 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) National Electrical Code, Boston: National Fire Protection Association, 60 Batterymarch Street, 1970.

INSTRUCTOR'S UNIT PLAN

Unit 13
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Reading Plans for a Whole House

AIM:

To involve the student in blueprint reading for the purpose of teaching him sense of the elements that are necessary in reading plans and ordering materials for a whole house.

INSTRUCTIONAL AIDS:

Chart - Showing electrical symbols.

EQUIPMENT:

Pencils, ruler, drawing paper, etc. (necessary to make rough drawings).

List of electrical symbols.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

I. INTRODUCTION AND MOTIVATION

A. We have just completed the planning and installation of a simple AC circuit. Now we will read the plans for a whole house in preparation for wiring that house in the next lesson.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Have all students turn to page 6 of the Sears Simplified Electric Wiring Handbook. Study and discuss general purpose circuits, 1-5.	1. At first glance, it would appear that all the devices were on one circuit. Is this really so?	1. Is it a good idea to put all the devices in a home on one branch circuit? Why not?
B. Study branches 6 and 7 on page 6.	1. Do general purpose circuits 1 to 5 all go to the same or different rooms? Study pages 4 and 5.	1. What is an underwriter's knot? (Hint: see p. 34)
C. On page 5, name the appliances. Check which branch circuit carries which appliance (see p. 6). 1. Discuss pages 8 and 9.	1. Note that the central air conditioner uses branches 10 and 12. Why does this unit require 2 branches?	1. On page 9 it states: "It is easy to set up efficient circuits." Do you agree?
D. Study and discuss pages 16 and 17. Pay particular attention on how to install nonmetallic cable.	1. Read "rules" for exposed work and "rules" for concealed work.	1. Read "How to Install a Ground Wire" (bottom of p. 16). Study drawing.
E. Study and discuss how to mount a ceiling box (see p. 23)		
F. See how to wire 3-way switches on p. 24.	1. Check p. 25 for wiring of switches, outlets and convenience outlets. Note wire colors.	
G. Turn to p. 271 in Richter's Practical Electrical Wiring. 1. Select most used symbols and have students make copies for their notebooks.	1. What is the practical value of electrical symbols. 2. Are letters ever used as electrical symbols?	
H. Have students make drawings of Fig. 16-3 on p. 274.	1. What is a "scale" drawing?	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Count the number of convenience outlets. 2. Add up the total wattages of all the devices on the single line. How does the amperage of <u>all</u> the devices compare to using a single branch circuit? $I = \frac{Watts}{110}$ 3. How would you distribute the loads on five branch circuits? After you have finished, turn to pages 4 and 5 and see how a professional engineer solved the problem.	1. You need the specifications for a certain appliance. How would you go about getting its specifications? 2. Once you have them, how do you interpret them? Using a set of specifications, explain them to the group and answer any questions that may arise.	1. How are school grades and home lighting related? 2. Electrician occupation: training, licensing, union membership, pay, advancement, and personal characteristics required.
1. How would you distribute the loads? Check your answer with pages 4 and 5.		1. Today, many homes are being built without cellars. In view of the atomic bomb, is this a good idea?
1. Calculate the number of amperes the air conditioner draws. $I = \frac{Watts}{240}$		
	1. Read "recommendations" on bottom of page 9.	

II. PRESENTATION OF INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
I. Have students study drawing on p. 275.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Have students make enlarged drawing of Fig. 16-5 on p. 275 (scale, etc.). a. Count number of convenience outlets b. Count number of toggle and 3-way switches c. Count number of overhead outlets, etc. d. Have whole class check on bill of materials so far e. Note where service entrance is in cellar f. Have students calculate amount of wire to order g. Include cellar in above lists h. What is total cost of material	1. Give room dimensions and have students draw to scale.	

III. APPLICATION

A. It is necessary for an electrician to be able to plan an installation and order materials for same. Thus, it is also necessary to know schematic symbols.

IV. EVALUATION CRITERIA GUIDELINE

A. The instructor shall watch the performance of his students by checking their requirements for materials as made up previously by himself.

V. SUMMARY

A. Much work and knowledge goes into the planning of a whole house. Always work from some prearranged table or plan. If you plan properly, you can make money. If you plan poorly, that is what your pocketbook will be.

VI. SUGGESTED TIME AND SEQUENCE LISTING

10 minutes -- Introduction and motivation

340 minutes -- Items A to I of presentation

10 minutes -- Summary

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 14
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Wiring the Whole House

AIM:

To have students wire a whole house.

INSTRUCTIONAL AIDS:

Made-up blueprints from Figures 16-5 and 16-6. (See pages 275-276 of reference text.) (Secure permission of McGraw-Hill Book Company to reproduce drawings.)

EQUIPMENT:

Student lists of materials, tools, and equipment necessary to wire a complete house. Balls of different colored string.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Divide students into teams of two men each. Assign one man to be supply clerk and tool crib man. Assign one man to be your assistant foreman. Pass out prints. Assign two men as a team to work and plan two rooms each; e.g., living room and dining room, kitchen and bath, bedrooms, two cellar rooms, etc. Teacher will act as foreman overseeing the work of the students. (Jobs will not be done on the first day.)

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Remove wiring from previous lesson. Save all usable materials.		
B. Show students how to trace out tentative branch circuits with colored string. One color for each branch.	1. Discuss feeder and branch circuits.	
C. Let assistant foreman help as much as possible.		
D. Have students go slowly because some branch circuits will be connected to other assigned rooms; e.g., dining room picks up its power from kitchen.		1. Detailed specifications may accompany some materials.
E. Student teams may have to consult together as to which boxes will be done first to keep out of each other's way.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Wire sizes and gauges. a. England - Imperial gauge b. U. S. - Steel wire gauge, American Standard wire gauge c. Other - Millimeters	1. Develop a paragraph or two describing the two rooms you are planning to wire. Keep in mind basic parts of speech, spelling and sentence construction.	1. History of wire manufacturing.

III. APPLICATION

A. Often, teams of electricians are broken into smaller groups on large construction jobs. Often, the "pusher" of each group will have to consult with the "pusher" in an adjoining area. Large construction companies will often have a "tool crib" man. If one team finishes ahead of another, then these men are assigned to teams that need help.

IV. EVALUATION CRITERIA GUIDELINE

A. Critique by teacher of the completed job.

V. SUMMARY

A. Whole house is wired. Critique at end. Question students as to alternative methods or routes that could have saved some material.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Issue of tools and material

330 minutes -- Actual electrical installation experience

15 minutes -- Hand in tools, clean up, etc.

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

INSTRUCTOR'S UNIT PLAN

Unit 15
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Wiring the Whole House (Continued)

AIM: To have students wire the whole house.

INSTRUCTIONAL AIDS:

Made-up blueprints from Figures 16-5 and 16-6. (See pages 275-276 of reference text.) (Secure permission of McGraw-Hill Book Company to reproduce drawings.)

EQUIPMENT:

Student lists of materials, tools, and equipment necessary to wire a complete house. Balls of different colored string.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Divide students into teams of two men each. Assign one man to be supply clerk and tool crib man. Assign one man to be your assistant foreman. Pass out prints. Assign two men as a team to work and plan two rooms each; e.g., living room and dining room, kitchen and bath, bedrooms, two cellar rooms, etc. Teacher will act as foreman overseeing the work of the students. (Jobs will not be done on the first day.)

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Continuation of Lesson 14.		
B. Discuss testing and circuit faults.		
C. Test each branch circuit separately.		
D. Turn on <u>all</u> lights!		
E. When whole house is completed, wiring can be removed and teams can be switched around to other parts of the house.		
F. HINT: Do not let students use same holes and mounts left by other students.		

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
	1. Using the previous paragraphs as models, discuss common grammatical and constructional errors. Develop the concept of good paragraph development including topic sentence and clincher sentence. Use previous paragraphs to illustrate whenever possible.	1. Benjamin Franklin. a. Biography b. Inventions in electricity

III. APPLICATION

A. Often, teams of electricians are broken into smaller groups on large construction jobs. Often, the "pusher" of each group will have to consult with the "pusher" in an adjoining area. Large construction companies will often have a "tool crib" man. If one team finishes ahead of another, then these men are assigned to teams that need help.

IV. EVALUATION CRITERIA GUIDELINE

A. Critique by teacher of the completed job.

V. SUMMARY

A. Whole house is wired. Critique at end. Question students as to alternative methods or routes that could have saved some material.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Issue of tools and material

330 minutes -- Actual electrical installation experience

15 minutes -- Hand in tools, clean up, etc.

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

INSTRUCTOR'S UNIT PLAN

Unit 16
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Miscellaneous Wiring Information and Wiring Large Appliances

AIM:

To become aware of "acceptable trade practices" in a variety of wiring situations.

INSTRUCTIONAL AIDS:

Pull chain outlet, several types of convenience outlet plugs (screw-type and "push in" type), several types of 3-way switches, regular and 2-circuit outlets, box covers, etc.; large appliance plugs, boxes, and terminal strips; one magnetic starter box.

EQUIPMENT:

As drawn out of tool crib by students.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

I. INTRODUCTION AND MOTIVATION

A. Prior to class, hook up three convenience outlet boxes so that the lines are short circuited because black to brass and white to silver "cross-over" causes a short circuit. Be sure above circuit is fused. Blow fuse or trip circuit breaker. Discuss what had been done and why. Discuss NEC code in regards to "acceptable trade practices."

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Discuss wiring of pull chain outlet (wires to and in outlet). 1. Black to black and white to white. 2. If terminals are silver and brass color, then white goes to silver and black goes to brass.	1. All items under "Instructional Topics" to be discussed as a means of integration of "acceptable practices."	1. At completion of A, B, C, etc., have students check their wiring to see if it checks out as "acceptable practice."
B. When wiring "receptacle outlets" black wire to brass and white wire to silver-colored screw.		
C. When outlet is controlled by wall switch, then black line is broken after a loop is formed. If switch is a long way off, run a black wire to the switch and back to the light.		
D. When taps are made in an outlet box, all white leads are connected together and all black leads are connected together.		
E. Three-way switches can be connected as follows: 1. Source-switch-switch-outlet. 2. Source-outlet-switch-switch. 3. Source-switch-outlet-switch.	1. Study illustrations on p. 320 and p. 321 in reference text by Richter.	1. Refresh students on which wires are "travelers" and why they must be used.
F. Discuss 1-circuit and 2-circuit receptacles. Also point out how 2-circuit receptacles can be converted to 1-circuit. (Hint: See p. 327 of reference text by Richter.)	1. Ordinary and 2-circuit receptacles on first glance might look exactly alike.	
G. Discuss the "Finishing" stage of installation of switches and other devices. (Material covered in Chapter 19, p. 334 of reference text by Richter.)	1. Need of proper finish after "rough" installation.	

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Students can calculate and order required wire, outlet boxes, covers, plugs, switches, etc. and estimate their cost. 2. Students can calculate labor cost of typical job.	1. Read and discuss "All Summer in a Day" by Ray Bradbury. Have students develop a piece of creative writing centered around the theme of "A World Without Electricity."	1. History and development of household appliances. a. World's Columbian Exposition in Chicago, 1893. b. Effects of World War II on appliance manufacturing

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
H. Wiring large appliances. 1. Electric range.	1. Needs 115-230 volt supply. 2. Use either rigid or thin wall (in most cases). 3. According to NEC: "service entrance cable may be used." 4. Range is equipped with a 3-wire cord and plug. 5. Range circuit terminates in H.D.-50 amp. receptacle.	
I. Automatic clothes dryer.	1. Usually a 230 V, 5 kw size. 2. Receptacle and plug seldom larger than 30 amp.	
J. Connecting a one 1-1/2 hp, 115 V, single phase motor.	1. Often uses a magnetic starting switch. 2. Magnetic starter is a separate unit and contains overcurrent device in the box. 3. Start switch capacity is usually 3 x motor rating, e.g., if a motor is rated at 20 amps., a 60 amp. (3 x 20) disconnect switch is used.	
K. Study p. 27 in Sears Simplified Electric Wiring Handbook (reference text) for Typical Electric Range or Dryer Hookup.		
L. Last three hours, work on wiring of complete house. If job is complete, remove wiring and assign different 2-men teams to different rooms or jobs.		

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Students will be involved in their own reinforcement of "acceptable trade practices" by checking their own work after discussion of each Instructional Topic. Students are to note discrepancies and correct them in second half of period.

IV. EVALUATION CRITERIA GUIDELINE

A. What is a magnetic switch?

B. How do you calculate the rating of a motor disconnect switch?

C. What is a 2-circuit receptacle?

D. Inspection and critique of students' work by instructor.

V. SUMMARY

A. Every device has its own "accepted trade practice" method of hookup. These are usually based on the NEC code. Apply these practices and you will look like a journeyman--don't apply them and you will be an apprentice as long as you last in the trade.

VI. SUGGESTED TIME AND SEQUENCE LISTING

15 minutes -- Introduction and motivation

150 minutes -- Demonstration, discussion, and inspection of work already done

180 minutes -- Work on home wiring

15 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) New York State Education Department, Related Information, Electricity I, II, III, IV, Albany, New York: Delmar Publishers, Inc. (undated but current).

INSTRUCTOR'S UNIT PLAN

Unit 17
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Three-Wire--230 V. AC

AIM:

To introduce the student to a very important area of electrical usage--three-phase--230 V. AC. To acquaint the student with some of the important concepts and trade practices in three-phase.

INSTRUCTIONAL AIDS:

Films - U. S. Navy, NOB, Philadelphia:
ME-7373A - Three-Phase Motors--Part 1--Preparing to Rewind (28 minutes)
ME-7373B - Three-Phase Motors--Part 2--Rewinding (17 minutes)

EQUIPMENT:

Sound motion picture projector and screen.

Tools and equipment as drawn out of tool crib by student teams.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

I. INTRODUCTION AND MOTIVATION

A. Prior to today, we considered mainly two-wire systems. Today, we will discuss three-wire systems--the system used in practically all modern homes.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. If there are three wires, codes as follows: 1. White--neutral. 2. Black--hot. 3. Red--hot. 4. Most modern residences use the 230 V. AC 3-wire service.	1. Recall that 2-wire cable is coded: white--neutral, black--hot lead. 2. Used to increase the number of appliances that can be used at one time. 3. Used in heavy appliances such as ranges, hot water heaters, space heaters, etc.	1. White to black = 115 V. AC. 2. White to red = 115 V. AC. 3. Black to red = 230 V. AC. 4. Three-wire systems are used to reduce voltage drop.
B. Study and discuss 3-wire service drop (p. 13, Sears reference text). 1. Study p. 12 (same ref. text). Note outer braid is "neutral" wire. 2. Note box is grounded to ground or earth.	1. Note white wire feeds "straight through." 2. White wire is "center" of 3-wire system. 3. Black wire of cable connects to left terminal--red to right.	1. A water pipe can be used for ground but the ground must be connected to street side of water meter. 2. Note how two black wires can be used for 230 V. AC in auxiliary panel.
C. Draw 3-wire system on blackboard and discuss equal and unequal loads. 1. Explain cancellation of equal currents. 2. Three-wire circuits need not carry a single load. Explain. (Hint: p. 364, Richter, reference text.)	1. In C-1, when loads are equal, currents are opposite, thus cancel each other out. 2. When loads are unequal, neutral will carry the algebraic difference between the two wires and in the direction of the larger.	1. Note: When using split loads, white wire must run to every outlet. 2. Define: "three-phase." 3. Discuss the greater efficiency of using higher voltage in heavy load demand equipment.
D. Show films: 1. ME-7373A. 2. ME-7373B.		
E. Continue with wiring buildings.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Using Ohm's law, students can calculate the increased amperage resulting from increased voltage. 2. Students can design high demand circuits requiring 230 voltage. By using typical resistance values they can then calculate current usage.	1. Using social studies concepts of inventions, have students react to their world without electricity and, in one paragraph, decide and defend which one invention they would like to have in their world. While they are doing this, go over previous writing with individual students.	1. What effect has increased inventions had on leisure time? What effect has leisure time had on inventions?

III. APPLICATION

A. Students will apply the facts and principles of this lesson throughout their working lives as electricians. Further, they will "see" the need for coded wires and will integrate these three colors and their usage into their working knowledge.

IV. EVALUATION CRITERIA GUIDELINE

A. Name the three colors found in a three-wire system.

B. What voltage exists between red and black?

C. What voltage exists between black and neutral?

D. What is the color of the neutral wire in a three-wire cable?

E. What voltage exists between red and neutral?

F. With balanced loads, what current flows in the neutral wire?

G. With unbalanced loads, what current flows in the neutral wire?

H. When the load is split, is it necessary to run a neutral wire to each outlet box? Why?

I. What is meant by "three phase"?

J. What type of service drop is used in most modern installations?

V. SUMMARY

A. Stress the advantages and disadvantages of three-phase, 230 V. AC wiring and use. Review recommended safety practices to use when working around three-phase equipment.

VI. SUGGESTED TIME AND SEQUENCE LISTING

5 minutes -- Introduction and motivation

95 minutes -- Discussion and study of three-wire systems

50 minutes -- Three-phase enrichment film

185 minutes -- Wiring of complete house

25 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Graham, K. C., Interior Electric Wiring, Parts 1 and 2, Chicago: American Technical Society, 1963 or later.

INSTRUCTOR'S UNIT PLAN

Unit 18
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Special Wiring for Residences

AIM:

To familiarize the student with some special wiring for residences.

To acquaint the student with some of the special circuits that are used in the home and for home-associated out-buildings.

EQUIPMENT:

Tools and materials as drawn out of tool crib by students.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

I. INTRODUCTION AND MOTIVATION

A. A house simply wired for lighting can be lived in. Indeed, since the dawn of history, man has lived with rudimentary light from a fire, or with no lighting at all. In a sense, any wiring besides heating and lighting comes under the broad classification of "convenience lighting" and "convenience circuitry." Today, we will discuss some of the "convenience" circuits. Probably, the ultimate in convenience circuits is the common flashlight.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Safety receptacles.	1. Spring-loaded covers to fail attempts of children from using hairpins, paper clips, etc.	1. Discuss the "electrically heated" home.
B. Swimming pools. 1. Pump motors. 2. Overhead lighting. 3. Underwater lighting.	1. Special underwater outlets and procedures for servicing.	1. Demonstrate the non-conductible nature of distilled water. a. Compare conduction of distilled water to tap water. b. Add a pinch of salt to distilled water to demonstrate the conductive nature of electrolytes.
C. Garage supply: 1. 2-wire if for lighting. 2. 3-wire if for power equipment. 3. Overhead doors--electrically operated.	1. Post lights along walks; garden lights. 2. TV rotors.	1. Caution students about the use of 3-wire line, especially in outdoor equipment usage.
D. Waterproof convenience outlets for: 1. Electrically powered mowers. 2. Bar-B-Que rotisseries, etc. 3. Temporary outdoor lighting.	1. 3-cluster lights, spike lights, etc. 2. Temporary extension lines.	
E. Farm lighting and outbuilding lighting: 1. Direct. 2. Yard pole. 3. Occasional need for separate metering. 4. Underground. 5. Special circuits for high amperage farm machinery and equipment.	1. See reference, "Sears Handbook," p. 40 to p. 47. 2. Investigate mobile homes.	1. Check on power requirements for: a. Milkhouse b. Farm shop (Hint: See Ref. Text, "Sears Handbook," pp. 44-45)
F. Continuation of rewiring the whole house.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Students may prepare a job estimate for the installation of various convenience items by utilizing electrical parts and appliances catalogs.	1. Using Warriner's or similar text, review basic punctuation stressing capitals and end line.	1. Early sources of light. 2. Effects of light sources and intensity on production.
1. Students may calculate the increase in electrical costs resulting from the use of convenience appliances.		

III. APPLICATION

A. Ordinary lighting circuits are the stock in trade of the practical electrician's work. Convenience or special circuits are the "extras." Often, the ingenuity of the electrician will be taxed to the uttermost in figuring ways to circumvent natural or man-made obstacles. At other times, cost factors can be vexing, or, the electrician will be "strung out" between the cost of "trenching" versus the esthetic disfigurement of overhead wires. This is a study that never ends.

IV. EVALUATION CRITERIA GUIDELINE

A. Name four common special circuits found in the "ordinary" home.

B. What is a yard pole?

C. Is it better to run 2-wire or 3-wire drops to outbuildings?

D. What is a "spike" light?

E. What is a safety outlet?

F. Under what circumstances would an outbuilding require its own metering?

G. What is a post light?

H. In general, would a garden light be above or below eye level?

V. SUMMARY

A. Special circuits for the home consist of "anything" the customer may desire. Among the special circuits are included: safety receptacles, swimming pool lighting, outside waterproof convenience plugs, garage light and power, garden lights, spike lights, yard poles and large outbuilding power and light. In general, the problems posed by some of these "convenience" circuits can be both vexing and troublesome. The practical electrician would do well to see how each special job is handled as he can never have enough "practical" experience.

VI. SUGGESTED TIME AND SEQUENCE LISTING

5 minutes -- Introduction and motivation

155 minutes -- Topics A to E under Instructional Topics

180 minutes -- Practical wiring of whole house

20 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) National Electrical Code, Boston: National Fire Protection Association, 60 Batterymarch Street, 1970.

INSTRUCTOR'S UNIT PLAN

Unit 19
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Circuit Failure--Troubleshooting

AIM:

To teach the student the reasons for circuit failure and some of the principles of troubleshooting.

INSTRUCTIONAL AIDS:

Filmstrips - U. S. Navy, NOB, Philadelphia:
SN-2743E - Basic Radio Troubleshooting--Continuity and Resistance
SN-2743B - Basic Radio Troubleshooting--Why Parts Fail
Film - U. S. Navy, NOB, Philadelphia:
MA-7812B - Circuit Testing with Meters and Multimeters--Practical Application (33 minutes)

EQUIPMENT:

Filmstrip projector, sound motion picture projector, screen, and materials and equipment as drawn from tool crib by students. Also some test lights, "ringers," and test probes.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. Show slides and film on troubleshooting.

B. Slides will show some devices which are used in electrical trades but which, usually, are neglected.

C. Students will want to discuss some of these little-used elements.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Show filmstrip SN-2743E: "Basic Radio Trouble-shooting--Continuity and Resistance." 1. Show film MA-7812B: Circuit Testing with Meters and Multimeters--Practical Application (33 minutes). 2. Show filmstrip SN-2743B: "Basic Radio Trouble-shooting--Why Parts Fail." (Select applicable frames--leave out vacuum tube section.)	1. Stress continuity testing.	1. One of the factors that govern the operation of an electrical circuit is a complete path or circuit. 2. Demonstrate the operation of fuses and circuit breakers. a. Discuss principles of operation of each b. Discuss and illustrate their proper installation in circuit
B. Why circuits fail: 1. Loose connection.	1. Loose screw in socket.	1. Remedy--cut all power, tighten screw in bottom, and check.
C. Improperly seated fuse or circuit breaker.	1. Fuse window clear and fuse checks ok.	1. Remedy--reseat fuse or circuit breaker. a. Note: Fuse may be too short for depth of socket
D. Short circuit--window of fuse is dirty or discolored. 1. A replacement blows immediately or breaker re-trips. 2. Show how a "neon" tester is used.	1. Can be dangerous--beware of FIRE! 2. Usually no visible clues. 3. These can be very tough--trouble can vary from a faulty appliance to a rat's nest. 4. If fuse blows when all appliances are removed, the short is in the wiring. 5. Explain "ringing out" a circuit. 6. Discuss the "MEGGER."	1. May be hard to find. Procedure to remedy: a. Unplug all lights and appliances b. Check. If short not clear, follow lines to junction box nearest panel box. Disconnect all leads. If clear, connect one circuit at a time. Trace circuit and locate. Use resistance readings. c. If clear--an appliance or light is cause. Examine all circuit elements and appliances. Plug circuit elements back onto line, one at a time until trouble reappears. Repair faulty element. d. Plug new fuse back into socket or restore circuit breaker.

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Students can calculate the proper load distribution on each fused circuit. 2. Students can calculate the economy of using more expensive circuit breakers over using fuses.	1. Exchange papers and in groups of two or more, "troubleshoot" for errors in construction.	1. Samuel Morse: a. Biography b. Contributions to electricity 2. Alexander Graham Bell's inventions and their impact on communications.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
E. Circuit overload. 1. Be sure to question customer closely if all you have to do is replace fuse. How often does the fuse blow? What appliances are usually on the line? Etc.	1. Very common cause of circuit failure. Window of fuse is usually clear because the fuse goes gradually. 2. If circuit breaker, you may have to wait a while for the circuit to go again.	1. Discuss temporary overload Can be overcome by temporarily disconnecting some rarely used appliances. Often can happen when a motor starts. (Use a time delay fuse.) Circuit breakers will withstand temporary overloads. 2. Constant overload: Shift some appliances to a new circuit, or, add a new circuit. Check appliances on all circuits before shifting. You may overload <u>that</u> other circuit! Make a list if necessary. Add wattages of elements and divide by 110. Check this against the rating of the overcurrent device.
F. Continue with practical work of wiring the whole house.		

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Every electrician should have a knowledge of trouble-shooting methods and equipment. Since troubles are often "unique," it is best to learn basic principles and use these for a guide. The speed with which an electrician can isolate a trouble will depend to a great degree on his knowledge of "troubleshooting" principles. It all starts with continuity.

IV. EVALUATION CRITERIA GUIDELINE

A. Name three types of continuity testers.

B. What is meant by "ringing?"

C. What is a megger?

D. Name three types of circuit failures.

E. What is a neon tester?

F. If circuit overcurrent devices do not blow when all appliances are removed from the line, where do you suspect the fault to lie?

G. If the fuse still "blows" after all appliances are removed from the line, where do you suspect the trouble to lie?

H. What is a temporary overload?

I. What is a common cause of temporary overload?

J. Name two cures for temporary overload.

V. SUMMARY

A. Some circuit problems can be so unique that their solution will test the electrician's ingenuity to the uttermost. On the other hand, some of the common faults are loose connections, frayed wires, temporarily overloaded circuits, and, in old houses, inadequate wiring. A thorough knowledge of continuity testing is a "must" for every practical electrician. Some are as simple as "tightening" a light bulb. Remember to question the customer carefully before proceeding. It will save you a lot of time. How often? When does the problem occur? Etc.

VI. SUGGESTED TIME AND SEQUENCE LISTING

50 minutes -- Introduction and motivation

100 minutes -- Instructional topics A to E

180 minutes -- Practical work, rewiring the whole house

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 20
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: ELECTRICAL

SUBJECT: Special Methods of Wiring

AIM:

To familiarize the student with some special methods of wiring such as special switches, dimmers, doorbells, chimes, large appliances and old work.

INSTRUCTIONAL AIDS:

Film - More Precious Than Gold, Detroit: General Motors Corp., Public Relations Staff, Film Library, General Motors Building (27 minutes).

EQUIPMENT:

Sound motion picture projector and screen.

Quiet and regular toggle switches, dimmers, doorbells, buzzers, chimes, large appliance plugs, etc.

PRIMARY REFERENCES:

1) Richter, H. P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1970.

2) Simplified Electric Wiring Handbook, F-5428, Chicago: Sears, Roebuck and Company, 1969.

I. INTRODUCTION AND MOTIVATION

A. Today you will see and we shall discuss some special methods of wiring. Also we will see a film about how man has come to consider that electrical power is more precious than gold. This is proven by the fact that an old gold field is flooded with water for electrical power.

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	*TECHNICAL CONCEPTS*	*SCIENCE*
A. Quiet switches.	1. "Silent" click useful in hospital rooms, bedrooms, and nurseries.	1. Mercury contacts. 2. Students will study the structure and operating principles involving dimmers and silent switches.
B. Dimmers.	1. Some people are "bothered" by ordinary levels of illumination and it is a comfort for them to be able to control the intensity of lighting.	1. Special dimming switches. 2. Review rheostats. 3. Up to 300 watts high-off-low switches are used.
C. Doorbells and chimes.	1. Usually, ordinary buzzers and transformers (6-10 V) are used. 2. Chimes usually require more power than bells (usually 15-20 V).	1. Use bell wire in most cases. 2. Fastened by "insulated staples." 3. Students can construct simple buzzers or chimes.
D. For large appliances.	1. Larger receptacles are a must. 2. See list of receptacle configurations, Figs. 21-1 and 21-2, p. 369, in Richter's ref. text.	1. Means of total disconnection must be provided.
E. Wiring 230 volt appliances with cable.	1. Grounded neutral does not run an operating 230 volt load.	1. Wires of 230 volt load may not be white. (2-wire, one white and one black, may not be used.) 2. Discuss Sec. 200-6(b) NEC code.
F. Old work. 1. Discuss with students advisability of studying carpentry framing to appreciate methods of running wires from box to different floors.	1. No work is simple. No book can tell how to proceed. Buildings must be studied. 2. Demonstrate how cuttings are made into old walls for box openings.	1. Show beveled boxes, drill extensions, long bits, etc. 2. Electrician should be familiar with building construction, framing, flooring, etc.
G. Show General Motors film: More Precious Than Gold (27 minutes).		
H. Continue to work on wiring house. Cleanup and tool inventory.		

TO BE DEVELOPED

MATH	*COMMUNICATIONS*	*SOCIAL STUDIES*
1. Students can calculate the increased cost of installing special switches and sounding devices. 2. Students may plan the installation of a large appliance which requires 230 volts. Problem involves ordering materials and job cost estimate.	1. Continued work in punctuation. Use of commas, semicolons and colons in making list.	1. Discussion of "craftsmanship" and "quantity" in producing goods and services. 2. Rationale for "planned obsolescence."

III. APPLICATION

A. The number and type of available devices that require special methods of wiring is worthy of a book all its own. This lesson deals with some of the more common devices with which the practical electrician should be familiar. Old work cannot be discussed too well in any textbook because no two old houses would have the same wiring and thus methods differ.

IV. EVALUATION CRITERIA GUIDELINE

A. Where are "quiet" switches used?

B. What is a dimmer?

C. Why is a transformer used on bells and chimes?

D. Which requires the higher voltage, bells or chimes?

E. What is the usual voltage range of bells? Of chimes?

F. What are insulated staples? Where are they used?

V. SUMMARY

A. Special methods of wiring differ so widely that it would take a textual treatment for this subject alone. Transformers for bells fall into the 6-10 volt range. Chimes require a higher voltage--12-16 volts. A special type of wire called "bell" wire is used to wire bells and chimes. The student should be familiar with "quiet" switches which are used in hospitals, bedrooms, and nurseries. Dimmers are of two basic types--switch and rheostat. (Switches are cheaper.) Large appliances require special sockets, plugs and wiring. Learn to look at specification sheets that accompany most special appliances.

B. Old work is best handled by experience and ingenuity.

VI. SUGGESTED TIME AND SEQUENCE LISTING

5 minutes -- Introduction and motivation

60 minutes -- Special circuits and devices

60 minutes -- Wiring of large appliances; NEC code

25 minutes -- Old work

30 minutes -- Film

180 minutes -- Continue work on wiring whole house, clean up, and inventory

B I B L I O G R A P H Y

Baer, Charles J., Electrical and Electronic Drawing, New York: McGraw-Hill Book Company, 1960, 2nd Edition.

Bredahl, A. C., Wiring Manual for Home and Farm, New York: McGraw-Hill Book Company, 1957.

Fischer, Electrical Blueprint Reading and Sketching--Industrial, Albany, New York: Delmar Publishers, Inc., 1969.

Fischer and Arendt, Electrical Blueprint Reading and Sketching--Commercial, Albany, New York: Delmar Publishers, Inc., 1969.

Graham, Kennard C., Industrial and Commercial Wiring, Chicago: American Technical Society, 1963, 2nd Edition.

Graham, Kennard C., Interior Electric Wiring: Residential, Chicago: American Technical Society, 1962, 6th Edition.

Graham, Kennard C., National Electrical Code and Blueprint Reading, Chicago: American Technical Society, 1963, 3rd Edition.

Heine, Gilbert M. et al., How to Read Electrical Blueprints, Chicago: American Technical Society, 1954, 2nd Edition.

Jones, Elmer W. and Johnston, John L., Adequate Wiring for Home and Farm, Milwaukee: Bruce Publishing Company, 1969.

Lush, Clifford K., Industrial-Arts Electricity, Peoria, Illinois: Charles A. Bennett Company, Inc., 1965.

Mix, Floyd and Pritchard, E. C., All About House Wiring, Homewood, Illinois: Goodheart-Willcox Company, Inc., 1968.

Moyer, J. A. and Wostrel, J. F., Industrial Electricity and Wiring, New York: McGraw-Hill Book Company, 1930.

Mullin, Electrical Blueprint Reading and Sketching--Residential, Albany, New York: Delmar Publishers, Inc., 1969.

Richter, Herbert P., Practical Electrical Wiring, New York: McGraw-Hill Book Company, 1967, 7th Edition.

Richter, Herbert P., Practical Electrical Wiring: House, Farm and Industrial, New York: McGraw-Hill Book Company, 1970.

Richter, H. P., Practical Electricity and House Wiring, Skokie, Illinois: F. J. Drake & Company, 1937.

A P P E N D I X

Films for Household and Industrial Wiring

U. S. Government Films: National Audio-Visual Center, Washington, D. C. 20409:

"Cable Surface Wiring," 17 minutes, 16 mm, black & white, #OE377

"Installing Conduit," 25 minutes, 16 mm, black & white, sound, #OE381

"Installing Surface Metal Raceway," 22 minutes, 16 mm, black & white, #OE380

"Joining Solid Conductors," 22 minutes, 16 mm, black & white, #OE369

"Porcelain Protected Surface Wiring," 19 minutes, 16 mm, black & white, #OE376

"Power Bending Conduit," 17 minutes, 16 mm, black & white, #OE382

"Roughing-In Nonmetallic Sheathbed Cable," 24 minutes, 16 mm, black & white, #OE373

"Soldering Lugs and Splicing Stranded Conductors," 18 minutes, 16 mm, black & white, #OE371

"Three-Wire Service Entrance," 24 minutes, 16 mm, sound, #OE374

"Wire Sizes and Voltage Drop," 13 minutes, 16 mm, sound, #OE372

"Wiring Old Buildings with Armored Cable," 22 minutes, #OE379

Republic Steel Corporation, Steel & Tubes Division, 1950:

"Easy Does It," 24 minutes, 16 mm, sound

National Electrical Manufacturing Association, Revised 1963:

"Installing Armoured Cable," 27 minutes, 16 mm

Filmstrip

Eye Gates House, Inc., Jamaica, New York:

"Building a House--Gas, Electric, Plumbing and Other Installations," 61-E

Transparencies

Delmar Publishers, Inc., Albany, New York:

15 Transparencies for Electrical Residential Installations

Diagrams

Howard W. Sams Company, Inc., Indianapolis, Indiana:

Wiring Diagrams for Light and Power